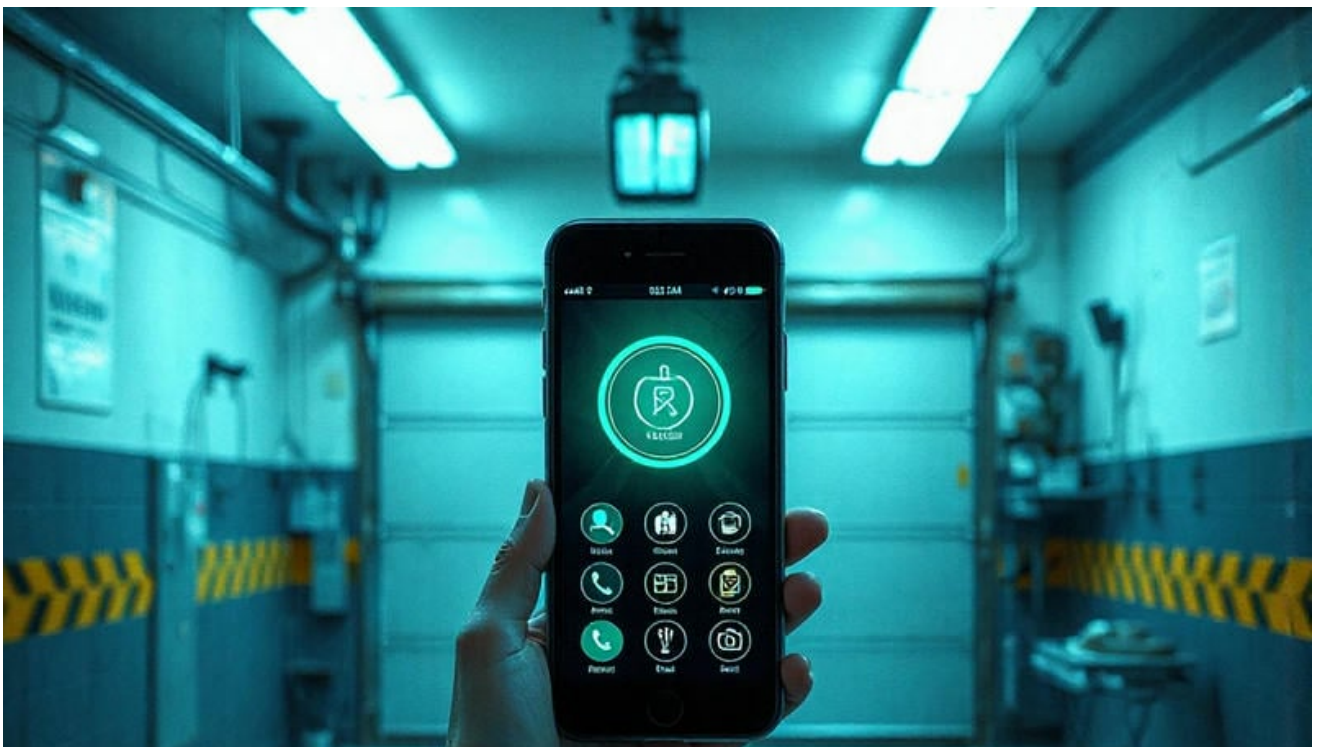


garage door designs



- **Identifying Common Causes of Garage Door Malfunctions**
Identifying Common Causes of Garage Door Malfunctions Step by Step Methods for Replacing Broken Springs Techniques for Realigning Garage Door Tracks Recognizing Signs of Worn Cables Addressing Sudden Door Stoppages During Operation Evaluating Garage Door Noise Issues Diagnosing Problems with Door Opener Sensors Quick Fixes for Sluggish Door Response Understanding Proper Balance in Garage Door Systems Inspecting Rollers for Smooth Movement Strategies for Resolving Intermittent Door Jams Confirming Adequate Tension in Garage Door Springs
- **Comparing Steel Wood and Aluminum Garage Doors**
Comparing Steel Wood and Aluminum Garage Doors Considering Natural Wood Finishes for Classic Appeal Evaluating Benefits of Powder Coated Surfaces Selecting Weather Resistant Materials for Exterior Conditions Understanding Differences in Garage Door Finishes Assessing Durability of Various Door Materials Approaches for Maintaining Painted Garage Door Surfaces Considering Environmental Impact of Material Choices Identifying Suitable Finish Options for Climate Conditions Techniques for Preserving Color in Garage Door Panels Practical Methods for Removing Surface Stains Balancing Aesthetics and Function in Material Selections
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In the realm of home maintenance, doors often go unnoticed until they become a source of frustration. Using a professional installer ensures proper alignment and function **door garage repair** interior design. We've all experienced that sluggish door response, where a once-smooth operation turns into a struggle. The importance of regular maintenance for optimal door performance cannot be overstated, especially when simple quick fixes could easily prevent these common issues.

Consider the role doors play in our daily lives. They are not just entryways but also silent guardians of privacy and security. When a door begins to stick or creak, it disrupts the harmony of domestic life, creating unnecessary stress and inconvenience. Regular maintenance is key to ensuring that doors function efficiently and seamlessly as intended.

One might wonder why such attention is necessary for something as mundane as a door. The answer lies in the intricate mechanism that allows a door to swing open and closed with ease. Hinges can rust, frames can misalign, and weather stripping can wear down over time. Without routine checks, these minor issues can escalate into significant problems requiring costly repairs or replacements.

Quick fixes for sluggish door response begin with observation; listen for unusual noises or feel for resistance when opening or closing the door. Often, applying lubricant to hinges or tightening loose screws can resolve these issues swiftly. Checking alignment is equally important-over time, homes settle, causing frames to shift slightly out of place. A simple adjustment using a screwdriver may be all that's needed to restore smooth operation.

Moreover, consider the impact of environmental factors such as humidity and temperature fluctuations on your doors. Wooden doors are particularly susceptible to swelling in humid conditions or contracting in dry weather. Regularly inspecting the fit between the door and its frame helps ensure there's adequate clearance for movement throughout different seasons.

In addition to addressing immediate concerns, incorporating preventive measures into your routine maintenance schedule will pay dividends in longevity and performance. Regular cleaning removes dust and debris that could interfere with moving parts while applying protective finishes guards against moisture damage.

Ultimately, cultivating a habit of regular maintenance transcends mere functionality-it extends the lifespan of your doors while enhancing their aesthetic appeal within your living space. By taking small but consistent steps towards upkeep now, you save yourself from greater inconvenience later on while preserving an essential component of your home's infrastructure.

In conclusion, while it may seem trivial at first glance compared to other household tasks demanding attention-a little care goes far when it comes down optimizing how effectively our trusty portals serve us day-to-day life without fussing about those pesky sluggish responses ever again!

Role of Quality Materials in Preventing Malfunctions —

- **Importance of Proper Alignment During Installation**
- **Role of Quality Materials in Preventing Malfunctions**
- **Impact of Incorrect Tension Settings on Garage Door Performance**
- **Common Electrical Issues Arising from Faulty Installations**
- **Influence of Environmental Factors on Installed Garage Doors**
- **Routine Maintenance Tips for Newly Installed Garage Doors**

When a door hesitates or lags in its response, it can be more than just an inconvenience; it often signals underlying issues that require attention. Quick fixes can sometimes address the symptoms, but identifying the root causes is essential for long-term solutions. Here are some quick inspection tips to help you diagnose potential problems and restore your door's functionality.

First, start by examining the alignment of the door. Misalignment is a common culprit behind sluggish response times. Over time, doors can shift due to wear and tear or changes in the structure of a building. Check if the door fits snugly within its frame. If you notice gaps or uneven spacing, realigning the hinges might be necessary. Tightening loose screws or replacing worn-out hinges could be all it takes to solve this issue.

Next, inspect the condition of the tracks and rollers, especially if you're dealing with sliding doors. Dirt and debris accumulation can hinder smooth operation. A thorough cleaning followed by lubrication with a silicone-based spray can often alleviate friction-related delays. Ensure that rollers are not worn out or damaged; replacing them might be needed if they show signs of excessive wear.

The door's hardware also deserves close scrutiny. Handles, locks, and other components should operate smoothly without sticking or jamming. If turning a knob or sliding a bolt requires extra effort, disassemble these parts for cleaning and lubrication. Sometimes, simply tightening loose components can make a significant difference.

Don't overlook weatherstripping as well-it plays a critical role in both sealing and ease of movement for certain types of doors like patio sliders or entryways exposed to elements. Worn-out weatherstripping not only affects energy efficiency but may also cause additional drag on your door's movement.

Another aspect worth investigating is any electrical componentry involved in automatic doors-sensors and motors need regular maintenance checks to ensure they're functioning correctly. Dust off sensors gently with a soft cloth to remove obstructions that might impede signal transmission.

Finally, consider environmental factors such as humidity levels which might affect wooden doors by causing them to swell or warp slightly during different seasons; this could alter their fit within frames leading them to respond sluggishly when opening/closing.

By systematically going through these inspection points-alignment checks, track/roller examination/cleaning/lubrication processes alongside hardware adjustments-you stand an excellent chance at pinpointing what exactly has been causing your slow-moving door woes while effectively addressing fundamental issues instead of merely applying temporary fixes!

More about us:

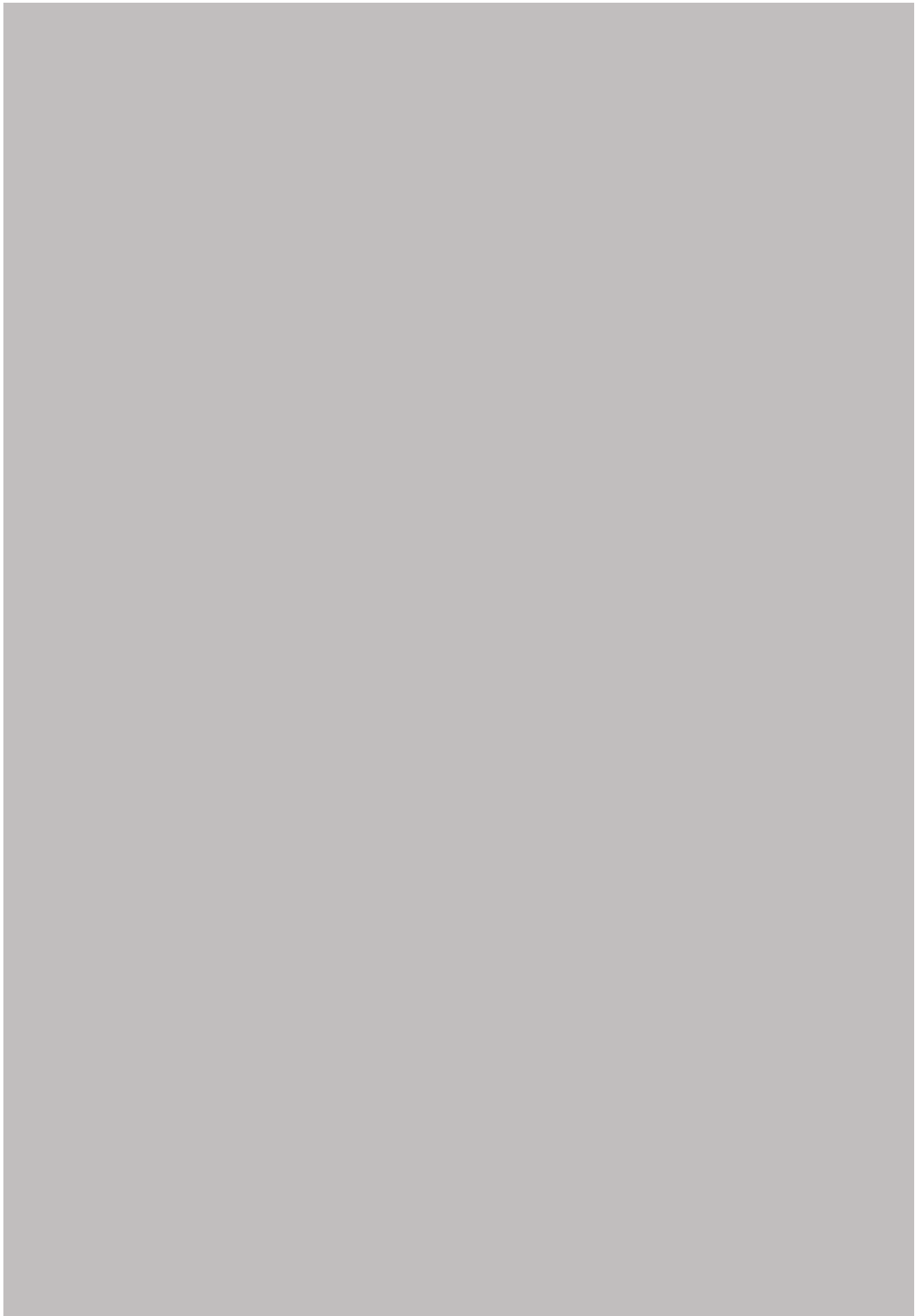
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Impact of Incorrect Tension Settings on Garage Door Performance

In the hustle and bustle of daily life, we often overlook the minor inconveniences that creep into our routines, such as a sluggish door response. It's easy to dismiss a creaky door or one that lags in its swing as mere nuisances, but these can accumulate into significant frustrations over time. Fortunately, there are simple lubrication techniques that can provide quick fixes for these pesky problems, ensuring smoother operation and restoring harmony to your home environment.

To understand why your door might be operating sluggishly, it's essential to consider what happens every time it moves. The hinges, which are pivotal in allowing the door to open and close smoothly, experience wear and tear from constant use. Dust particles, moisture, and general dirt accumulation can exacerbate this wear by causing increased friction between moving parts. This friction not only slows down the door's operation but can also create unpleasant noises like squeaking or grinding.

One of the most straightforward solutions is regular lubrication of the door hinges. This might sound like an overly simplistic approach, but it's surprisingly effective in restoring a sluggish door to its original smoothness. The process begins by selecting an appropriate lubricant; products such as WD-40 or silicone spray are popular choices due to their ease of use and effectiveness in reducing friction.

Once you have your lubricant ready, begin by opening the door fully to access all hinge components easily. Wipe away any visible dust or grime with a clean cloth; this step ensures that you're not trapping debris inside when applying the lubricant. Shake the lubricant container well before spraying it directly onto each hinge point. Be sure to cover both sides: where the pin meets the hinge plates and where the plates meet each other.

After applying the lubricant generously yet carefully, work it into the mechanism by swinging the door back and forth several times. This action helps distribute the lubricant evenly across all moving parts while also immediately showing improvements in ease of movement-many find that previously stubborn doors glide effortlessly after this treatment.

For those seeking more environmentally friendly alternatives or dealing with sensitive materials like antique woodwork or painted surfaces, natural lubricants such as beeswax or olive oil can serve as substitutes. These options are less likely to cause damage if excess comes into contact with surrounding surfaces while still providing adequate lubrication for everyday purposes.

Regular maintenance is key; even after resolving initial sluggishness issues through lubrication techniques described here today-this isn't necessarily goodbye forever when it comes down encountering similar problems again later on! Make sure incorporate routine checks every few months just keep everything running smoothly long term future ahead without having revisit same old problem spots repeatedly unnecessarily so quickly thereafter instead enjoying newfound peace quiet well-oiled machinery brings own right ultimately making life little bit easier whole lot better overall satisfaction guaranteed!

In conclusion: don't let something seemingly insignificant disrupt your day-to-day activities further than already does now-take charge utilize simple yet effective solutions available whenever need arises next time around thereby ensuring optimal performance consistency throughout lifetime ownership whatever type entryway currently possessing wish enjoy fullest extent possible today tomorrow beyond alike!



Common Electrical Issues Arising from Faulty

Installations

In today's fast-paced world, convenience is a prized commodity. The garage door opener, once a marvel of modern technology, has become an essential part of our daily routine. Yet, like all machines, it can sometimes falter, leading to frustration and inconvenience. If your garage door opener has become sluggish or unresponsive, fear not: a few simple adjustments can often restore its optimal performance.

A common issue with garage door openers is their slow response time. This delay can be particularly bothersome when you're in a hurry or dealing with inclement weather. Fortunately, there are several quick fixes you can try to improve the responsiveness of your system.

First and foremost, check the batteries in your remote control. It might sound too simple to be true, but weak batteries are frequently the culprits behind delayed responses. Replacing these batteries with fresh ones can often resolve the issue immediately. Additionally, ensure that there is no interference between the remote and the receiver on the garage door opener; electronic devices or physical obstructions could be blocking the signal.

Another key factor in improving responsiveness is adjusting the settings on your garage door opener itself. Most models come equipped with sensitivity settings that determine how much force is needed to start moving the door. If these settings are too high, they may cause unnecessary delays in response time. Consult your owner's manual for instructions on how to adjust these sensitivity levels appropriately.

Similarly, examine the travel limit settings on your opener. These settings control how far the door must travel before fully opening or closing and can affect how quickly it responds to commands. Ensuring that these limits are correctly set will promote smoother operation and quicker responses.

Lubrication also plays a vital role in maintaining an efficient garage door system. Over time, components such as rollers and tracks can accumulate dirt and debris which impede movement and lead to slower responses. Regularly applying a silicone-based lubricant will minimize friction and allow for seamless operation.

Beyond mechanical adjustments, consider performing a basic reset of your system by unplugging it from power for about thirty seconds before plugging it back in again—a method akin to rebooting a computer when facing technical glitches.

Lastly but importantly—safety first! Always disconnect power before making any adjustments directly involving hardware mechanisms like springs or chains—and if unsure about tackling more complex issues yourself—it's advisable not only out of caution but practicality—to consult professional assistance rather than risk personal injury or further damage.

In essence—a little maintenance goes a long way towards ensuring reliable functionality out-of-the-box convenience we've come to expect rely upon daily basis—from those handy overhead motors quietly going about their business until called action open close command issued via fob console button press alike—all contributing seamlessly keep life moving forward without hitch!

Influence of Environmental Factors on Installed Garage Doors

In the hustle and bustle of daily life, a sluggish door can be an unexpected hindrance. Whether it's the front door that welcomes you home or the garage door that safeguards your vehicle, every door has a role to play in our routines. Yet, over time, these gateways begin to falter, often due to worn-out components like springs or rollers. Understanding how to address these issues not only ensures smooth operation but also extends the longevity of your doors.

The heart of any well-functioning door lies in its hardware. Springs and rollers are among the most critical components that facilitate seamless movement. Over time, however, they endure constant pressure and friction which can lead to wear and tear. A spring that's lost its tension or a roller that's developed flat spots can significantly impede a door's performance.

To tackle this issue effectively, it's essential first to diagnose the problem accurately. Listen for unusual sounds such as squeaking or grinding when operating the door-these are telltale signs of component distress. Visual inspections can also reveal noticeable wear on parts like rollers, which may appear chipped or cracked.

Once you've identified worn-out parts as the culprit behind sluggish response, replacing them is usually a straightforward process-a quick fix that breathes new life into your doors. Start by gathering necessary tools such as wrenches and screwdrivers along with replacement parts sourced from reliable suppliers. For those who prefer professional assistance, hiring a technician is always an option; however, many homeowners find satisfaction in handling minor repairs themselves.

When replacing springs, safety should be paramount given their tension-loaded nature. Properly secure the door before attempting any repairs to avoid accidents. Similarly, swapping out old rollers involves removing them from their tracks-an uncomplicated task but one requiring precision to ensure proper alignment upon reinstallation.

Beyond resolving current issues with sluggishness, regular maintenance checks can prevent future problems from arising altogether. Lubricating moving parts periodically reduces friction and prolongs their lifespan while keeping operations noise-free and smooth.

In conclusion, addressing worn-out springs or rollers might seem trivial at first glance but plays a crucial role in maintaining efficient door function within our homes and workplaces alike. By taking proactive steps towards repair and upkeep now rather than later down-the-line when problems escalate beyond simple fixes-homeowners not only save time but also safeguard investments made in quality fixtures for years ahead without unnecessary hassle!



Routine Maintenance Tips for Newly Installed Garage Doors

When addressing the issue of sluggish door response, one often overlooked yet vital component is the proper alignment of tracks and sensors. This alignment is crucial for ensuring that doors operate smoothly and efficiently, minimizing delays and enhancing user experience. A misalignment can cause a host of problems, from slow responses to complete malfunctions, which can be frustrating and inconvenient for users.

The tracks on which doors glide must be meticulously aligned to allow seamless movement. Over time, these tracks can become misaligned due to regular wear and tear or external forces such as impacts or environmental changes. When tracks are not properly aligned, they create friction that hinders the smooth operation of the door. This friction not only slows down the door's response but can also lead to increased wear on mechanical components, potentially resulting in costly repairs.

Similarly, sensors play an integral role in the functioning of automatic doors by detecting motion or presence and signaling the door to open or close accordingly. If these sensors are misaligned, they may fail to detect objects accurately, resulting in delayed responses or even safety hazards if doors close unexpectedly. Ensuring that sensors are correctly positioned is key to maintaining both efficiency and safety standards.

To remedy these issues quickly, regular maintenance checks should be conducted. During such checks, ensure that tracks are clear of debris and free from any obstructions that could impede movement. Using a level tool can help verify that tracks remain straight and true over their entire length. For sensor alignment, it's important to consult manufacturer guidelines for optimal positioning; most modern systems offer calibration options that allow adjustments without requiring professional intervention.

In summary, while it may seem like a small detail amidst larger operational concerns, ensuring proper alignment of tracks and sensors is essential for preventing sluggish door response. By paying attention to these elements through routine maintenance and adjustments when necessary, one can significantly improve door performance-making daily interactions with automatic doors smoother and more efficient for everyone involved.

About warranty

The examples and perspective in this article **deal primarily with the United States** and **do not represent a worldwide view of the subject**. You may improve this article, discuss the issue on the talk page, or create a new article, as appropriate. (September 2010) *(Learn how and when to remove this message)*



This article's lead section **may be too technical for most readers to understand**. Please help improve it to make it understandable to non-experts, without removing the technical details. *(March 2021) (Learn how and when to remove this message)*

In law, a **warranty** is an expressed or implied promise or assurance of some kind. The term's meaning varies across legal subjects.^[1] In property law, it refers to a covenant by the grantor of a deed.^[2] In insurance law, it refers to a promise by the purchaser of an insurance about the thing or person to be insured.^[3]

In contract law, a warranty is a contractual assurance given, typically, by a seller to a buyer,^[4] for example confirming that the seller is the owner of the property being sold.^[5] A warranty is a term of a contract, but not usually a condition of the contract or an innominate term, meaning that it is a term "not going to the root of the contract",^[6] and therefore only entitles the innocent party to damages if it is breached,^[6] i.e. if the warranty is not true or the defaulting party does not perform the contract in accordance with the terms of the warranty. A warranty is not a guarantee: it is a mere promise. It may be enforced if it is breached by an award for the legal remedy of damages.

Depending on the terms of the contract, a product warranty may cover a product such that a manufacturer provides a warranty to a consumer with whom the manufacturer has no direct contractual relationship because it is purchased via an intermediary.

A warranty may be express or implied. An express warranty is expressly stated (typically, written); whether or not a term will be implied into a contract depends on the particular contract law of the country in question. Warranties may also state that a particular fact is true at a point in time, or that the fact will continue into the future (a "continuing warranty").

Express warranty

[edit]

Main article: Express warranties

Express warranties are created when the seller makes a guarantee to the buyer that the product or service being offered has certain qualities. For there to exist an express warranty, a statement regarding the product or service must be made to the buyer and the statement must play a role in the buyer's decision to purchase the product or service. If, after purchase, the buyer feels that the given statement was a misrepresentation of the actual product or service, the buyer can file for breach of express warranty.^[7]

Implied warranty

[edit]

Main article: Implied warranty

Implied warranties are unwritten promises that arise from the nature of the transaction, and the inherent understanding by the buyer, rather than from the express representations of the seller.

Sale of goods

[edit]

Main article: Sale of goods

Warranties provided in the sale of goods (tangible products) vary according to jurisdiction, but commonly new goods are sold with implied warranty that the goods are as advertised. Used products, however, may be sold "as is" with no warranties. Each country, however, defines its own parameters with regard to implied conditions or implied warranties. The rules regarding warranties are largely standardised; i.e., the concepts of *offer*, *acceptance*, *consideration*, *capacity to contract* and *intention to create legal relations*. Those are the five elements to create a legally binding contract in the United States (all 50 states), England and Wales, Scotland and Northern Ireland, each of the seven states of Australia, and all other common law countries. Countries with civil law systems, however, recognise legally binding contracts which are not supported by consideration.^[*citation needed*]

United States

[edit]

In the United States, various laws apply, including provisions in the Uniform Commercial Code which provide for implied warranties.^[8] However, these implied warranties were often limited by disclaimers. In 1975 the Magnuson–Moss Warranty Act was passed to strengthen warranties on consumer goods.^[9] Among other things, under the law implied warranties cannot be disclaimed if an express warranty is offered, and attorney fees may be recovered.^[9] In some states, statutory warranties are required on new home construction, and "lemon laws" apply to motor vehicles.

Article 2 of the Uniform Commercial Code, which has been adopted with variations in each state, provides that the following two warranties are implied unless they are explicitly disclaimed (such as an "as is" statement):

- The **warranty of merchantability** is implied unless expressly disclaimed by name, or the sale is identified with the phrase "as is" or "with all faults." To be "merchantable", the goods must reasonably conform to an ordinary buyer's expectations. For example, a fruit that looks and smells good but has hidden defects may violate the warranty if its quality does not meet the standards for such fruit "as passes ordinarily in the trade". In most states, products inherently come with implied warranty of merchantability; however, in states like Massachusetts under consumer protection law, it is illegal to disclaim this warranty on household goods sold to consumers. (Massachusetts General Laws, Chapter 106: Section 2-316A)

- The **warranty of fitness for a particular purpose** is implied unless disclaimed when a buyer relies upon the seller to select the goods to fit a specific request. For example, this warranty is violated when a buyer asks a mechanic to provide tires for use on snowy roads and receives tires that are unsafe to use in snow.

Defects In Materials and Workmanship

[edit]

A common kind of warranty on goods is a warranty that the product is free from material defects in materials and workmanship. This simply promises that the manufacturer properly constructed the product, out of proper materials. This implies that the product is not defective for the purposes for which it was made.

Warranties may be time limited, thus limiting the time the buyer has to make a claim for breach of warranty. For example, a typical 90-day warranty on a television gives the buyer 90 days from the date of purchase to claim that the television was improperly constructed. Should the television fail after 91 days of normal usage, which because televisions customarily last longer than 91 days means there was a defect in the materials or workmanship of the television, the buyer nonetheless may not collect on the warranty because it is too late to file a claim. Consumer protection laws implemented by statute, however, provide additional remedies as it is not usually expected that a television will last for only 90 days.

Time-limited warranties are often confused with performance warranties. A 90-day performance warranty would promise that the television would work for 90 days, which is fundamentally different from promising that it was delivered free of defects and limiting the time the buyer has to prove otherwise. But because the usual evidence that a product was delivered defective is that it later breaks, the effect is very similar.

One situation in which the effect of a time-limited warranty is different from the effect of a performance warranty is where the time limit exceeds a normal lifetime of the product. If a coat is designed to last two years, but has a 10-year limited warranty against defects in materials and workmanship, a buyer who wears the coat for 3 years and then finds it worn out would not be able to collect on the warranty. But it is different from a 2-year warranty because if the buyer starts wearing the coat 5 years after buying it, and finds it wears out a year later, the buyer would have a warranty claim in Year 6. On the other hand, a 10-year performance warranty would promise that the coat would last 10 years.

Satisfaction guarantee

[edit]

In the United States, the Magnuson–Moss Warranty Act of 1976 provides for enforcement of a satisfaction guarantee warranty. In these cases, the advertiser must refund the full purchase price regardless of the reason for dissatisfaction.^[10]

Lifetime warranty

[edit]

A lifetime warranty is usually a warranty against defects in materials and workmanship that has no time limit to make a claim, rather than a warranty that the product will perform for the lifetime of the buyer.^[11] The actual time that product can be expected to perform is normally determined by the custom for products of its kind used the way the buyer uses it.

If a product has been discontinued and is no longer available, the warranty may last a limited period longer. For example:

- the Cisco Limited Lifetime Warranty currently lasts for five years after the product has been discontinued, but only if you know where you bought it from as the seller is responsible for administering it.^[12]
- HP Networking product lifetime warranties last for as long as one owns the product.^[13]

Limited warranty

[edit]

A warranty may be limited in duration (as above) and/or in scope. In *Avrora Fine Arts v Christie, Manson and Woods* (a UK High Court case), the auctioneers had issued a "limited warranty" that a certain painting sold at auction had been painted by the Russian painter Boris Kustodiev, which experts subsequently stated was not the case. The sale was cancelled and the buyer was reimbursed, but further claims of negligence and misrepresentation were denied because they fell outside the warranty's scope.^[14]

Breach of warranty

[edit]

Warranties are breached when the promise is not performed at all, or not performed in accordance with the contract. The seller may honor the warranty by making a refund or a replacement. The statute of limitations depends on the jurisdiction and contractual agreements. In the United States, the Uniform Commercial Code § 2-725 provides for a four-year time limit, which can be limited to one year by contract, starting from the date of delivery or if future performance is guaranteed from the date of discovery. Refusing to honor the warranty may be an unfair business practice. In the United States, breach of warranty lawsuits may be distinct from revocation of contract suits; in the case of the breach of warranty, the buyer's item is repaired or replaced while breach of contract involves returning the item to the seller.^[15]

Warranty label on top of a hard disk

Image not found or type unknown

Warranty label on top of a hard disk

Warranty label lifted. The word "VOID" is shown multiple times

Image not found or type unknown

Warranty label lifted. The word "VOID" is shown multiple times.

Some warranties require that repairs be undertaken by an authorized service provider. In such cases, service by non-authorized personnel or company may void (nullify) the warranty. However, according to the Magnuson-Moss Act (a U.S. Federal law that governs warranties, which was passed in 1975), if the warranty does not provide full or partial payment of labor (to repair the device or system), it is the owner's choice who will provide the labor, including the possibility of DIY ("Do It Yourself") repairs, in which case the device or system owner will pay zero dollars for labor, yet the company that provided the warranty must still provide all the parts needed for the repair at absolutely no charge to the owner.

If the defective product causes injury, this may be a cause of action for a product liability lawsuit (tort). Strict liability may be applied.

Extended warranty

[edit]

In addition to standard warranties on new items, third parties or manufacturers may sell or offer extended warranties (also called service contracts).^[16] These extend the warranty for a further length of time. However, these warranties have terms and conditions which may not match the original terms and conditions. For example, these may not cover anything other than mechanical failure from normal usage. Exclusions may include commercial use, "acts of God", owner abuse, and malicious destruction. They may also exclude parts that normally wear out such as tires and lubrication on a vehicle.

These types of warranties are provided for various products, but automobiles and electronics are common examples. Warranties which are sold through retailers such as

Best Buy may include significant commission for the retailer as a result of reverse competition.^[17] For instance, an auto warranty from a car dealership may be subcontracted and vehicle repairs may be at a lower rate which could compromise the quality of service. At the time of repair, out-of-pocket expenses may be charged for unexpected services provided outside of the warranty terms or uncovered parts. Extended Warranties are mostly back to back underwritten by underwriters, who are the actual bearer of the risk.

Representations versus warranties

[edit]

Further information: Misrepresentation

Statements of fact in a contract or in obtaining the contract are considered to be either warranties or representations. Traditionally, warranties are factual promises which are enforced through a contract legal action, regardless of materiality, intent, or reliance.^[18] Representations are traditionally *pre*contractual statements which allow for a tort-based action if the misrepresentation is innocent, negligent or fraudulent.^[19] In U.S. law, the distinction between the two is somewhat unclear;^[18] warranties are viewed as primarily contract-based legal action while negligent or fraudulent misrepresentations are tort-based, but there is a confusing mix of case law in the United States.^[18] In modern English law, sellers often avoid using the term 'represents' in order to avoid claims under the Misrepresentation Act 1967 (although English law will look to the substance rather than the form of the representation to decide what it is), while in America 'warrants and represents' is relatively common.^[20] Some modern commentators suggest avoiding the words and substituting 'state' or 'agree', and some model forms do not use the words;^[19] however, others disagree.^[21]

Product types

[edit]

Appliance warranty

[edit]

Canada and United States

[edit]

Written warranties on new major appliances, such as refrigerators, kitchen stoves and dishwashers, usually cover the cost of parts and labor to repair defects in materials or workmanship which appear under normal home use.

Warranties often cover defects up to a year after purchase or delivery.^[22] However some exclude new owners when a house or appliance is sold within the year (Frigidaire,^[23] LG,^[24] Samsung^[25]). Others do let warranties transfer to new buyers (Amana,^[26] General Electric,^[27] Whirlpool). Some manufacturers cover refrigerators' sealed parts (compressors, tubing, etc.) for five years (General Electric,^[27] Samsung,^[28] Whirlpool)^[25] or seven years (LG^[24]) or ten years (KitchenAid^[29]).

Warranties on water heaters cover parts for 5 to 12 years in single family residences, one year otherwise. They do not cover new owners when a house or heater is sold; nor do they cover the original owner if the heater is moved to a second location.^[30]^[31]^[32]^[33]^[34] Tank models from A. O. Smith do not allow heating elements to be replaced with lower (or higher) wattages, and do not cover renter-occupied single family. They end if the unit is flooded or ever uses desalinated or deionized water, such as municipal desalination plants or reverse osmosis filters.^[32]^[33] Smith's tank models for manufactured housing do not provide coverage if a whirlpool or hot tub is connected.^[33]

Tank water heater warranties exclude labor, liability for water damage, and shipping cost to return the old heater or parts. Tankless warranties do not exclude water damage; they cover labor for a year, and Ruud/Rheem covers return shipping on tankless models.^[31]^[34] Smith's tankless water heaters do not restrict coverage to a single family, and require professional installation.^[34]

Implied warranties under US law could extend for longer periods. However, most states allow the written warranties to include clauses which limit these implied warranties to the same time period as the written warranty.^[35]

Car warranty

[edit]

United States

[edit]

New car factory warranties commonly range from one year to five years and in some cases extend even 10 years, with typically a mileage limit as well. Car warranties can be extended by the manufacturer or other companies with a renewal fee.

Used car warranties are usually 3 months and 3,000 miles.

United Kingdom

[edit]

In the United Kingdom, types of warranties have been classified as either an:

1. original manufacturer warranty,
2. insurance warranty underwritten and regulated as insurance or
3. obligor warranty, typically written by a car dealership or garage.

In the United Kingdom, the Financial Conduct Authority (FCA), which began to regulate insurance contracts in this context in 2005, determined that additional warranties sold by car dealerships are "unlikely to be insurance".^[36] Insurance warranties may offer greater protection to the consumer.

Home Warranty

[edit]

Main article: Home warranty

A home warranty protects against the costs of home and appliance repair by offering home warranty coverage for houses, townhomes, condominiums, mobile homes, and new construction homes. When a problem occurs with a covered appliance or mechanical system such as an air conditioning unit or furnace, a service technician repairs or replaces it. The homeowner may have to pay for a service call fee and the home warranty company pays the balance for the repair or replacement of the covered item.

Intellectual property right warranty

[edit]

An intellectual property right (IPR) warranty provides contractual protection against breach of rights in software development and other fields where IPR is protected. Increasing reluctance on the part of suppliers to offer an IPR warranty or indemnity has been noted in recent years.^[37]

Warranty data

[edit]

Warranty data consists of claims data and supplementary data. Claims data are the data collected during the servicing of claims under warranty and supplementary data are additional data such as production and marketing data.^[38] This data can help determine product reliability and plan for future modifications.^[38]

See also

[edit]

- Business law

- Collateral TORT
- Consumer protection
- Due diligence
- Extended warranty
- Magnuson-Moss Warranty Act
- Surety
- Warranty deed
- Warranty tolling

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[edit]

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External links

[edit]

- o Federal Trade Commission: Warranty Information (United States)

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National

- o Germany
- o Czech Republic

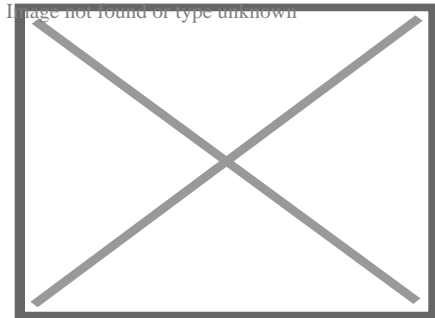
Other

- o Encyclopedia of Modern Ukraine

About light-emitting diode

This article is about the electronic device. For specific use in lighting, see LED lamp. "LED" and "Led" redirect here. For other uses, see LED (disambiguation).

Light-emitting diode



Blue, green, and red LEDs in 5 mm diffused cases. There are many different variants of LEDs.

Working principle

Inventor

First production

Pin names

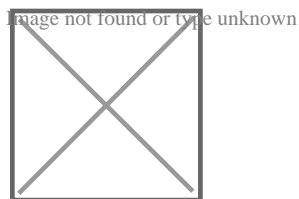
Electroluminescence

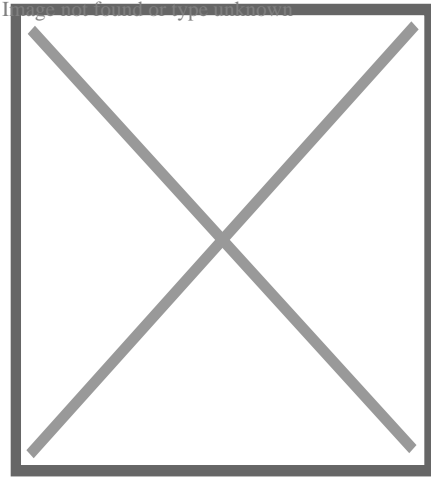
- o H. J. Round (1907)^[1]
- o Oleg Losev (1927)^[2]
- o James R. Biard (1961)^[3]
- o Nick Holonyak (1962)^[4]

October 1962; 62 years ago

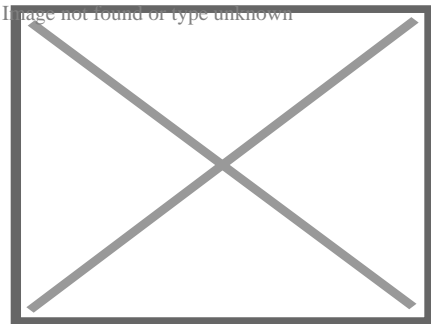
Anode and cathode

Electronic symbol





Parts of a conventional LED. The flat bottom surfaces of the anvil and post embedded inside the epoxy act as anchors, to prevent the conductors from being forcefully pulled out via mechanical strain or vibration.



Close-up image of a surface-mount LED

Close-up of an LED with the voltage being increased and decreased to show a detailed view of its operation

Modern LED retrofit with E27 screw in base

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A bulb-shaped modern retrofit LED lamp with aluminum heat sink, a light diffusing dome and E27 screw base, using a built-in power supply working on mains voltage

A **light-emitting diode (LED)** is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.^[5] White light is obtained by using multiple semiconductors or a layer of

light-emitting phosphor on the semiconductor device.^[6]

Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared (IR) light.^[7] Infrared LEDs are used in remote-control circuits, such as those used with a wide variety of consumer electronics. The first visible-light LEDs were of low intensity and limited to red.

Early LEDs were often used as indicator lamps, replacing small incandescent bulbs, and in seven-segment displays. Later developments produced LEDs available in visible, ultraviolet (UV), and infrared wavelengths with high, low, or intermediate light output, for instance, white LEDs suitable for room and outdoor lighting. LEDs have also given rise to new types of displays and sensors, while their high switching rates are useful in advanced communications technology with applications as diverse as aviation lighting, fairy lights, strip lights, automotive headlamps, advertising, general lighting, traffic signals, camera flashes, lighted wallpaper, horticultural grow lights, and medical devices.^[8]

LEDs have many advantages over incandescent light sources, including lower power consumption, a longer lifetime, improved physical robustness, smaller sizes, and faster switching. In exchange for these generally favorable attributes, disadvantages of LEDs include electrical limitations to low voltage and generally to DC (not AC) power, the inability to provide steady illumination from a pulsing DC or an AC electrical supply source, and a lesser maximum operating temperature and storage temperature.

LEDs are transducers of electricity into light. They operate in reverse of photodiodes, which convert light into electricity.

History

[edit]

Main article: History of LEDs

The first LED was created by Soviet inventor Oleg Losev^[9] in 1927, but electroluminescence was already known for 20 years, and relied on a diode made of silicon carbide.

Commercially viable LEDs only became available after Texas Instruments engineers patented efficient near-infrared emission from a diode based on GaAs in 1962.

From 1968, commercial LEDs were extremely costly and saw no practical use. Monsanto and Hewlett-Packard led the development of LEDs to the point where, in the 1970s, a unit cost less than five cents.^[10]

Physics of light production and emission

[edit]

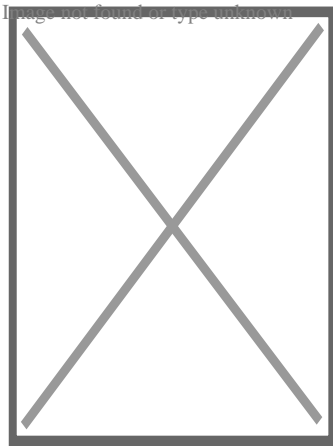
Main article: Light-emitting diode physics

In a light-emitting diode, the recombination of electrons and electron holes in a semiconductor produces light (be it infrared, visible or UV), a process called "electroluminescence". The wavelength of the light depends on the energy band gap of the semiconductors used. Since these materials have a high index of refraction, design features of the devices such as special optical coatings and die shape are required to efficiently emit light.^[11]

Unlike a laser, the light emitted from an LED is neither spectrally coherent nor even highly monochromatic. Its spectrum is sufficiently narrow that it appears to the human eye as a pure (saturated) color.^[12]^[13] Also unlike most lasers, its radiation is not spatially coherent, so it cannot approach the very high intensity characteristic of lasers.

Single-color LEDs

[edit]



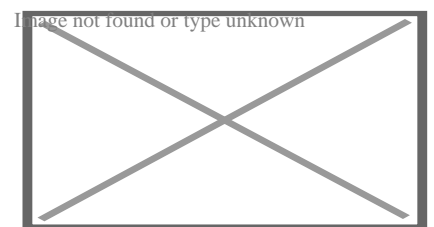
Blue LEDs

By selection of different semiconductor materials, single-color LEDs can be made that emit light in a narrow band of wavelengths from near-infrared through the visible spectrum and into the ultraviolet range. The required operating voltages of LEDs increase as the emitted wavelengths become shorter (higher energy, red to blue), because of their increasing semiconductor band gap.

Blue LEDs have an active region consisting of one or more InGaN quantum wells sandwiched between thicker layers of GaN, called cladding layers. By varying the relative In/Ga fraction in the InGaN quantum wells, the light emission can in theory be varied from violet to amber.

Aluminium gallium nitride (AlGaN) of varying Al/Ga fraction can be used to manufacture the cladding and quantum well layers for ultraviolet LEDs, but these devices have not yet

External videos



"The Original Blue LED",
Science History Institute

reached the level of efficiency and technological maturity of InGaN/GaN blue/green devices. If unalloyed GaN is used in this case to form the active quantum well layers, the device emits near-ultraviolet light with a peak wavelength centred around 365 nm. Green LEDs manufactured from the InGaN/GaN system are far more efficient and brighter than green LEDs produced with non-nitride material systems, but practical devices still exhibit efficiency too low for high-brightness applications.^[citation needed]

With AlGaIn and AlGaInN, even shorter wavelengths are achievable. Near-UV emitters at wavelengths around 360–395 nm are already cheap and often encountered, for example, as black light lamp replacements for inspection of anti-counterfeiting UV watermarks in documents and bank notes, and for UV curing. Substantially more expensive, shorter-wavelength diodes are commercially available for wavelengths down to 240 nm.^[14] As the photosensitivity of microorganisms approximately matches the absorption spectrum of DNA, with a peak at about 260 nm, UV LED emitting at 250–270 nm are expected in prospective disinfection and sterilization devices. Recent research has shown that commercially available UVA LEDs (365 nm) are already effective disinfection and sterilization devices.^[15] UV-C wavelengths were obtained in laboratories using aluminium nitride (210 nm),^[16] boron nitride (215 nm)^{[17][18]} and diamond (235 nm).^[19]

White LEDs

[edit]

There are two primary ways of producing white light-emitting diodes. One is to use individual LEDs that emit three primary colors—red, green and blue—and then mix all the colors to form white light. The other is to use a phosphor material to convert monochromatic light from a blue or UV LED to broad-spectrum white light, similar to a fluorescent lamp. The yellow phosphor is cerium-doped YAG crystals suspended in the package or coated on the LED. This YAG phosphor causes white LEDs to appear yellow when off, and the space between the crystals allow some blue light to pass through in LEDs with partial phosphor conversion. Alternatively, white LEDs may use other phosphors like manganese(IV)-doped potassium fluorosilicate (PFS) or other engineered phosphors. PFS assists in red light generation, and is used in conjunction with conventional Ce:YAG phosphor.

In LEDs with PFS phosphor, some blue light passes through the phosphors, the Ce:YAG phosphor converts blue light to green and red (yellow) light, and the PFS phosphor converts blue light to red light. The color, emission spectrum or color temperature of white phosphor converted and other phosphor converted LEDs can be controlled by changing the concentration of several phosphors that form a phosphor blend used in an LED package.^{[20][21][22][23]}

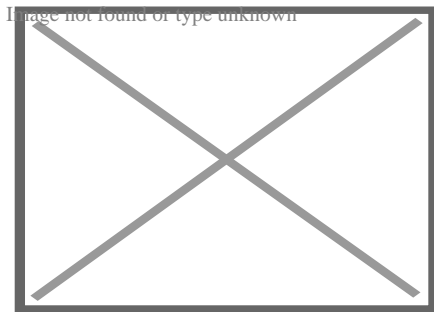
The 'whiteness' of the light produced is engineered to suit the human eye. Because of metamerism, it is possible to have quite different spectra that appear white. The appearance of objects illuminated by that light may vary as the spectrum varies. This is the issue of color rendition, quite separate from color temperature. An orange or cyan object

could appear with the wrong color and much darker as the LED or phosphor does not emit the wavelength it reflects. The best color rendition LEDs use a mix of phosphors, resulting in less efficiency and better color rendering.^[citation needed]

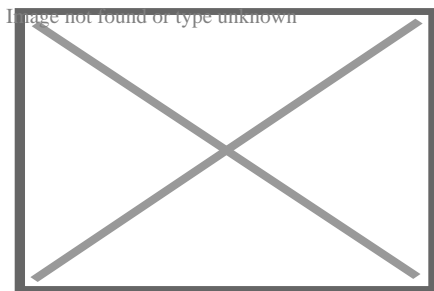
The first white light-emitting diodes (LEDs) were offered for sale in the autumn of 1996.^[24] Nichia made some of the first white LEDs which were based on blue LEDs with Ce:YAG phosphor.^[25] Ce:YAG is often grown using the Czochralski method.^[26]

RGB systems

[edit]



Combined spectral curves for blue, yellow-green, and high-brightness red solid-state semiconductor LEDs. FWHM spectral bandwidth is approximately 24–27 nm for all three colors.



An RGB LED projecting red, green, and blue onto a surface

Mixing red, green, and blue sources to produce white light needs electronic circuits to control the blending of the colors. Since LEDs have slightly different emission patterns, the color balance may change depending on the angle of view, even if the RGB sources are in a single package, so RGB diodes are seldom used to produce white lighting. Nonetheless, this method has many applications because of the flexibility of mixing different colors,^[27] and in principle, this mechanism also has higher quantum efficiency in producing white light.^[28]

There are several types of multicolor white LEDs: di-, tri-, and tetrachromatic white LEDs. Several key factors that play among these different methods include color stability, color rendering capability, and luminous efficacy. Often, higher efficiency means lower color rendering, presenting a trade-off between the luminous efficacy and color rendering. For

example, the dichromatic white LEDs have the best luminous efficacy (120 lm/W), but the lowest color rendering capability. Although tetrachromatic white LEDs have excellent color rendering capability, they often have poor luminous efficacy. Trichromatic white LEDs are in between, having both good luminous efficacy (>70 lm/W) and fair color rendering capability. [29]

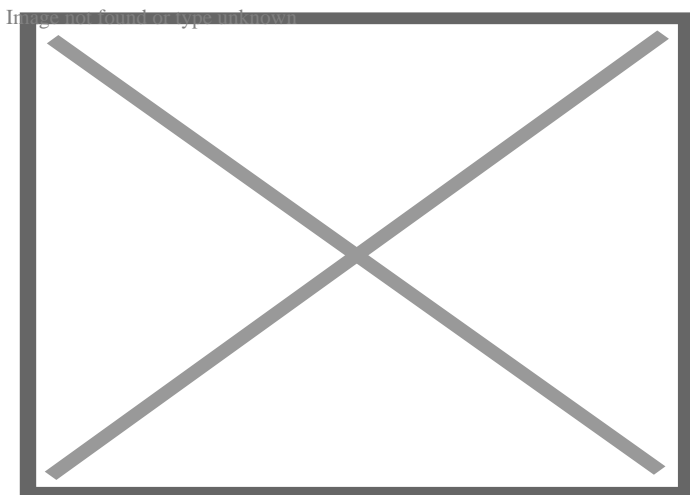
One of the challenges is the development of more efficient green LEDs. The theoretical maximum for green LEDs is 683 lumens per watt but as of 2010 few green LEDs exceed even 100 lumens per watt. The blue and red LEDs approach their theoretical limits. [citation needed]

Multicolor LEDs offer a means to form light of different colors. Most perceivable colors can be formed by mixing different amounts of three primary colors. This allows precise dynamic color control. Their emission power decays exponentially with rising temperature, [30] resulting in a substantial change in color stability. Such problems inhibit industrial use. Multicolor LEDs without phosphors cannot provide good color rendering because each LED is a narrowband source. LEDs without phosphor, while a poorer solution for general lighting, are the best solution for displays, either backlight of LCD, or direct LED based pixels.

Dimming a multicolor LED source to match the characteristics of incandescent lamps is difficult because manufacturing variations, age, and temperature change the actual color value output. To emulate the appearance of dimming incandescent lamps may require a feedback system with color sensor to actively monitor and control the color. [31]

Phosphor-based LEDs

[edit]

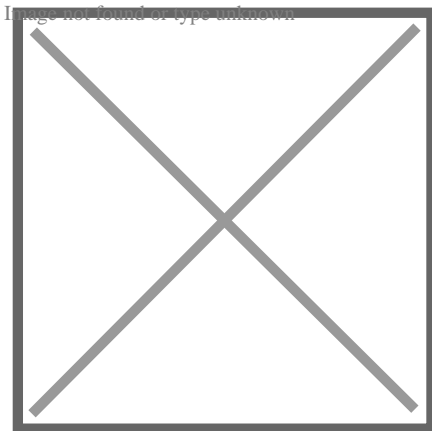


Spectrum of a white LED showing blue light directly emitted by the GaN-based LED (peak at about 465 nm) and the more broadband Stokes-shifted light emitted by the Ce³⁺:YAG phosphor, which emits at roughly 500–700 nm

This method involves coating LEDs of one color (mostly blue LEDs made of InGaN) with phosphors of different colors to form white light; the resultant LEDs are called phosphor-based or phosphor-converted white LEDs (pcLEDs).^[32] A fraction of the blue light undergoes the Stokes shift, which transforms it from shorter wavelengths to longer. Depending on the original LED's color, various color phosphors are used. Using several phosphor layers of distinct colors broadens the emitted spectrum, effectively raising the color rendering index (CRI).^[33]

Phosphor-based LEDs have efficiency losses due to heat loss from the Stokes shift and also other phosphor-related issues. Their luminous efficacies compared to normal LEDs depend on the spectral distribution of the resultant light output and the original wavelength of the LED itself. For example, the luminous efficacy of a typical YAG yellow phosphor based white LED ranges from 3 to 5 times the luminous efficacy of the original blue LED because of the human eye's greater sensitivity to yellow than to blue (as modeled in the luminosity function).

Due to the simplicity of manufacturing, the phosphor method is still the most popular method for making high-intensity white LEDs. The design and production of a light source or light fixture using a monochrome emitter with phosphor conversion is simpler and cheaper than a complex RGB system, and the majority of high-intensity white LEDs presently on the market are manufactured using phosphor light conversion.^[citation needed]



1 watt 9 volt three chips SMD phosphor based white LED

Among the challenges being faced to improve the efficiency of LED-based white light sources is the development of more efficient phosphors. As of 2010, the most efficient yellow phosphor is still the YAG phosphor, with less than 10% Stokes shift loss. Losses attributable to internal optical losses due to re-absorption in the LED chip and in the LED packaging itself account typically for another 10% to 30% of efficiency loss. Currently, in the area of phosphor LED development, much effort is being spent on optimizing these devices to higher light output and higher operation temperatures. For instance, the efficiency can be raised by adapting better package design or by using a more suitable type of phosphor. Conformal coating process is frequently used to address the issue of varying phosphor thickness.^[citation needed]

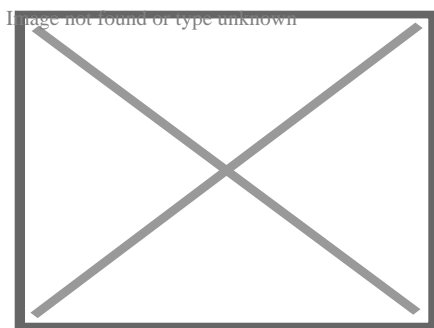
Some phosphor-based white LEDs encapsulate InGaN blue LEDs inside phosphor-coated epoxy. Alternatively, the LED might be paired with a remote phosphor, a preformed polycarbonate piece coated with the phosphor material. Remote phosphors provide more diffuse light, which is desirable for many applications. Remote phosphor designs are also more tolerant of variations in the LED emissions spectrum. A common yellow phosphor material is cerium-doped yttrium aluminium garnet ($\text{Ce}^{3+}:\text{YAG}$).^[citation needed]

White LEDs can also be made by coating near-ultraviolet (NUV) LEDs with a mixture of high-efficiency europium-based phosphors that emit red and blue, plus copper and aluminium-doped zinc sulfide ($\text{ZnS}:\text{Cu, Al}$) that emits green. This is a method analogous to the way fluorescent lamps work. This method is less efficient than blue LEDs with YAG:Ce phosphor, as the Stokes shift is larger, so more energy is converted to heat, but yields light with better spectral characteristics, which render color better. Due to the higher radiative output of the ultraviolet LEDs than of the blue ones, both methods offer comparable brightness. A concern is that UV light may leak from a malfunctioning light source and cause harm to human eyes or skin.^[citation needed]

A new style of wafers composed of gallium-nitride-on-silicon (GaN-on-Si) is being used to produce white LEDs using 200-mm silicon wafers. This avoids the typical costly sapphire substrate in relatively small 100- or 150-mm wafer sizes.^[34] The sapphire apparatus must be coupled with a mirror-like collector to reflect light that would otherwise be wasted. It was predicted that since 2020, 40% of all GaN LEDs are made with GaN-on-Si. Manufacturing large sapphire material is difficult, while large silicon material is cheaper and more abundant. LED companies shifting from using sapphire to silicon should be a minimal investment.^[35]

Mixed white LEDs

[edit]



Tunable white LED array in a floodlight

There are RGBW LEDs that combine RGB units with a phosphor white LED on the market. Doing so retains the extremely tunable color of RGB LED, but allows color rendering and efficiency to be optimized when a color close to white is selected.^[36]

Some phosphor white LED units are "tunable white", blending two extremes of color temperatures (commonly 2700K and 6500K) to produce intermediate values. This feature allows users to change the lighting to suit the current use of a multifunction room.^[37] As illustrated by a straight line on the chromaticity diagram, simple two-white blends will have a pink bias, becoming most severe in the middle. A small amount of green light, provided by another LED, could correct the problem.^[38] Some products are RGBWW, i.e. RGBW with tunable white.^[39]

A final class of white LED with mixed light is dim-to-warm. These are ordinary 2700K white LED bulbs with a small red LED that turns on when the bulb is dimmed. Doing so makes the color warmer, emulating an incandescent light bulb.^[39]

Other white LEDs

[edit]

Another method used to produce experimental white light LEDs used no phosphors at all and was based on homoepitaxially grown zinc selenide (ZnSe) on a ZnSe substrate that simultaneously emitted blue light from its active region and yellow light from the substrate.^[40]

Organic light-emitting diodes (OLEDs)

[edit]

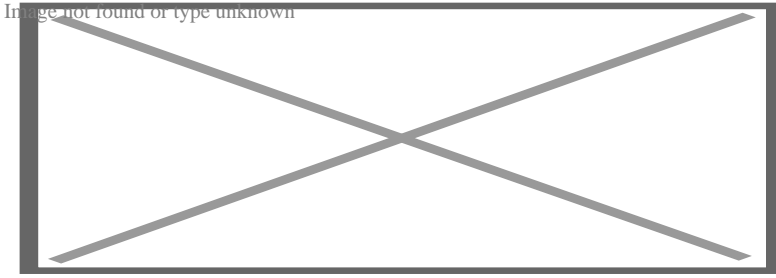
Main article: OLED

In an organic light-emitting diode (OLED), the electroluminescent material composing the emissive layer of the diode is an organic compound. The organic material is electrically conductive due to the delocalization of pi electrons caused by conjugation over all or part of the molecule, and the material therefore functions as an organic semiconductor.^[41] The organic materials can be small organic molecules in a crystalline phase, or polymers.^[42]

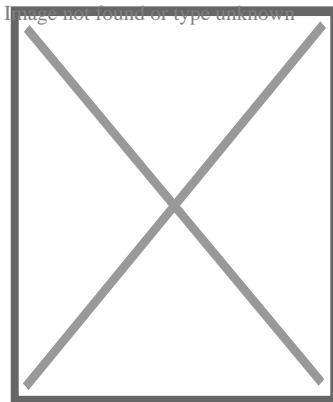
The potential advantages of OLEDs include thin, low-cost displays with a low driving voltage, wide viewing angle, and high contrast and color gamut.^[43] Polymer LEDs have the added benefit of printable and flexible displays.^{[44][45][46]} OLEDs have been used to make visual displays for portable electronic devices such as cellphones, digital cameras, lighting and televisions.^{[42][43]}

Types

[edit]



LEDs are produced in a variety of shapes and sizes. The color of the plastic lens is often the same as the actual color of light emitted, but not always. For instance, purple plastic is often used for infrared LEDs, and most blue devices have colorless housings. Modern high-power LEDs such as those used for lighting and backlighting are generally found in surface-mount technology (SMT) packages (not shown).



A variety of different diffused 5 mm THT-LEDs

- Red, 650 – 625nm
- Orange, 600 – 610nm
- Yellow, 587 – 591nm
- Green, 570 – 575nm
- Blue, 465 – 467nm
- Purple, 395 – 400nm

LEDs are made in different packages for different applications. A single or a few LED junctions may be packed in one miniature device for use as an indicator or pilot lamp. An LED array may include controlling circuits within the same package, which may range from a simple resistor, blinking or color changing control, or an addressable controller for RGB devices. Higher-powered white-emitting devices will be mounted on heat sinks and will be used for illumination. Alphanumeric displays in dot matrix or bar formats are widely available. Special packages permit connection of LEDs to optical fibers for high-speed data communication links.

Miniature

[edit]

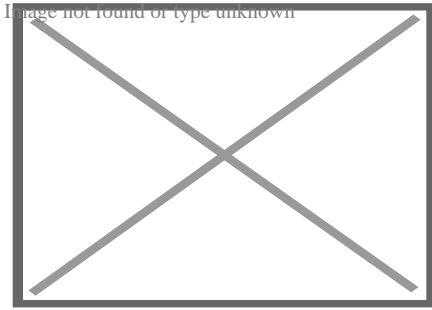
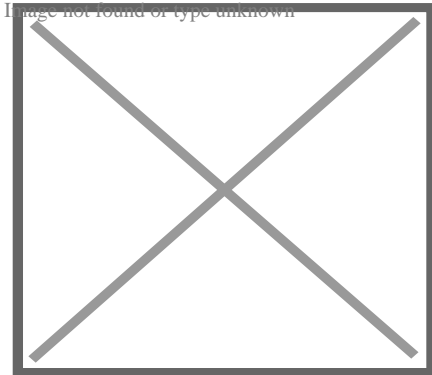


Image of miniature surface mount LEDs in most common sizes. They can be much smaller than a traditional 5 mm lamp type LED, shown on the upper left corner.



Very small (1.6×1.6×0.35 mm) red, green, and blue surface mount miniature LED package with gold wire bonding details

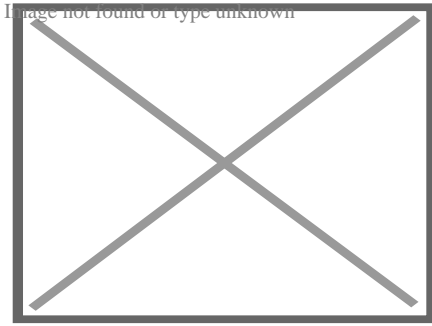
These are mostly single-die LEDs used as indicators, and they come in various sizes from 1.8 mm to 10 mm, through-hole and surface mount packages.^[47] Typical current ratings range from around 1 mA to above 20 mA. LED's can be soldered to a flexible PCB strip to form LED tape popularly used for decoration.

Common package shapes include round, with a domed or flat top, rectangular with a flat top (as used in bar-graph displays), and triangular or square with a flat top. The encapsulation may also be clear or tinted to improve contrast and viewing angle. Infrared devices may have a black tint to block visible light while passing infrared radiation, such as the Osram SFH 4546.^[48]

5 V and 12 V LEDs are ordinary miniature LEDs that have a series resistor for direct connection to a 5 V or 12 V supply.^[49]

High-power

[edit]



High-power light-emitting diodes attached to an LED star base (Luxeon, Lumileds)

See also: Solid-state lighting, LED lamp, and Thermal management of high-power LEDs

High-power LEDs (HP-LEDs) or high-output LEDs (HO-LEDs) can be driven at currents from hundreds of mA to more than an ampere, compared with the tens of mA for other LEDs. Some can emit over a thousand lumens.^{[50][51]} LED power densities up to 300 W/cm² have been achieved. Since overheating is destructive, the HP-LEDs must be mounted on a heat sink to allow for heat dissipation. If the heat from an HP-LED is not removed, the device fails in seconds. One HP-LED can often replace an incandescent bulb in a flashlight, or be set in an array to form a powerful LED lamp.

Some HP-LEDs in this category are the Nichia 19 series, Lumileds Rebel Led, Osram Opto Semiconductors Golden Dragon, and Cree X-lamp. As of September 2009, some HP-LEDs manufactured by Cree exceed 105 lm/W.^[52]

Examples for Haitz's law—which predicts an exponential rise in light output and efficacy of LEDs over time—are the CREE XP-G series LED, which achieved 105 lm/W in 2009^[52] and the Nichia 19 series with a typical efficacy of 140 lm/W, released in 2010.^[53]

AC-driven

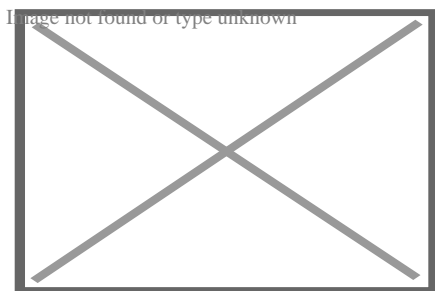
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LEDs developed by Seoul Semiconductor can operate on AC power without a DC converter. For each half-cycle, part of the LED emits light and part is dark, and this is reversed during the next half-cycle. The efficiency of this type of HP-LED is typically 40 lm/W.^[54] A large number of LED elements in series may be able to operate directly from line voltage. In 2009, Seoul Semiconductor released a high DC voltage LED, named 'Acrich MJT', capable of being driven from AC power with a simple controlling circuit. The low-power dissipation of these LEDs affords them more flexibility than the original AC LED design.^[55]

Strip

[edit]

This section is an excerpt from LED strip light.[edit]



Several LED spots being reflected as continuous lighting strip

An LED strip, tape, or ribbon light is a flexible circuit board populated by surface-mount light-emitting diodes (SMD LEDs) and other components that usually comes with an adhesive backing. Traditionally, strip lights had been used solely in accent lighting, backlighting, task lighting, and decorative lighting applications, such as cove lighting. LED strip lights originated in the early 2000s. Since then, increased luminous efficacy and higher-power SMDs have allowed them to be used in applications such as high brightness task lighting, fluorescent and halogen lighting fixture replacements, indirect lighting applications, ultraviolet inspection during manufacturing processes, set and costume design, and growing plants.

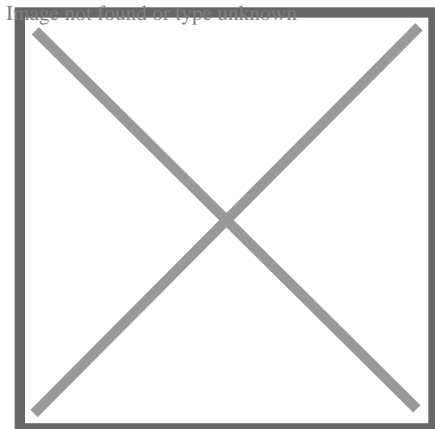
Application-specific

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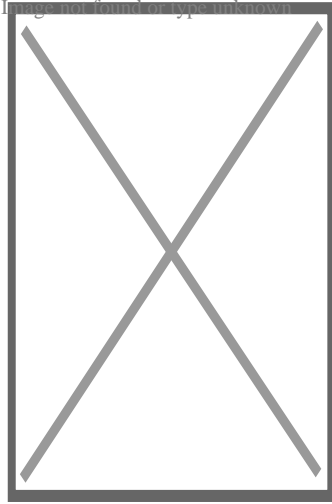


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RGB-SMD-LED



Composite image of an 11 × 44 LED matrix label name tag display using 1608/0603-type SMD LEDs. Top: A little over half of the 21 × 86 mm display. Center: Close-up of LEDs in ambient light. Bottom: LEDs in their own red light.

Flashing

Flashing LEDs are used as attention seeking indicators without requiring external electronics. Flashing LEDs resemble standard LEDs but they contain an integrated voltage regulator and a multivibrator circuit that causes the LED to flash with a typical period of one second. In diffused lens LEDs, this circuit is visible as a small black dot. Most flashing LEDs emit light of one color, but more sophisticated devices can flash between multiple colors and even fade through a color sequence using RGB color mixing. Flashing SMD LEDs in the 0805 and other size formats have been available since early 2019.

Flickering

Integrated electronics Simple electronic circuits integrated into the LED package have been around since at least 2011 which produce a random LED intensity pattern reminiscent of a flickering candle.^[56] Reverse engineering in 2024 has suggested that some flickering LEDs with automatic sleep and wake modes might be using an integrated 8-bit microcontroller for such functionality.^[57]

Bi-color

Bi-color LEDs contain two different LED emitters in one case. There are two types of these. One type consists of two dies connected to the same two leads antiparallel to each other. Current flow in one direction emits one color, and current in the opposite direction emits the other color. The other type consists of two dies with separate leads for both dies and another lead for common anode or cathode so that they can be controlled independently. The most common bi-color combination is red/traditional green. Others include amber/traditional green, red/pure green, red/blue, and blue/pure green.

RGB tri-color

Tri-color LEDs contain three different LED emitters in one case. Each emitter is connected to a separate lead so they can be controlled independently. A four-lead arrangement is typical with one common lead (anode or cathode) and an additional lead for each color. Others have only two leads (positive and negative) and have a

built-in electronic controller. RGB LEDs consist of one red, one green, and one blue LED.^[58] By independently adjusting each of the three, RGB LEDs are capable of producing a wide color gamut. Unlike dedicated-color LEDs, these do not produce pure wavelengths. Modules may not be optimized for smooth color mixing.

Decorative-multicolor

Decorative-multicolor LEDs incorporate several emitters of different colors supplied by only two lead-out wires. Colors are switched internally by varying the supply voltage.

Alphanumeric

Alphanumeric LEDs are available in seven-segment, starburst, and dot-matrix format. Seven-segment displays handle all numbers and a limited set of letters. Starburst displays can display all letters. Dot-matrix displays typically use 5×7 pixels per character. Seven-segment LED displays were in widespread use in the 1970s and 1980s, but rising use of liquid crystal displays, with their lower power needs and greater display flexibility, has reduced the popularity of numeric and alphanumeric LED displays.

Digital RGB

Digital RGB addressable LEDs contain their own "smart" control electronics. In addition to power and ground, these provide connections for data-in, data-out, clock and sometimes a strobe signal. These are connected in a daisy chain, which allows individual LEDs in a long LED strip light to be easily controlled by a microcontroller. Data sent to the first LED of the chain can control the brightness and color of each LED independently of the others. They are used where a combination of maximum control and minimum visible electronics are needed such as strings for Christmas and LED matrices. Some even have refresh rates in the kHz range, allowing for basic video applications. These devices are known by their part number (WS2812 being common) or a brand name such as NeoPixel.

Filament

An LED filament consists of multiple LED chips connected in series on a common longitudinal substrate that forms a thin rod reminiscent of a traditional incandescent filament.^[59] These are being used as a low-cost decorative alternative for traditional light bulbs that are being phased out in many countries. The filaments use a rather high voltage, allowing them to work efficiently with mains voltages. Often a simple rectifier and capacitive current limiting are employed to create a low-cost replacement for a traditional light bulb without the complexity of the low voltage, high current converter that single die LEDs need.^[60] Usually, they are packaged in bulb similar to the lamps they were designed to replace, and filled with inert gas at slightly lower than ambient pressure to remove heat efficiently and prevent corrosion.

Chip-on-board arrays

Surface-mounted LEDs are frequently produced in chip on board (COB) arrays, allowing better heat dissipation than with a single LED of comparable luminous output.^[61] The LEDs can be arranged around a cylinder, and are called "corn cob lights" because of the rows of yellow LEDs.^[62]

Considerations for use

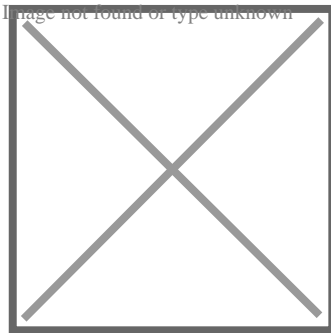
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- Efficiency: LEDs emit more lumens per watt than incandescent light bulbs.^[63] The efficiency of LED lighting fixtures is not affected by shape and size, unlike fluorescent light bulbs or tubes.
- Size: LEDs can be very small (smaller than 2 mm²^[64]) and are easily attached to printed circuit boards.

Power sources

[edit]

Main article: LED power sources



Simple LED circuit with resistor for current limiting

The current in an LED or other diodes rises exponentially with the applied voltage (see Shockley diode equation), so a small change in voltage can cause a large change in current. Current through the LED must be regulated by an external circuit such as a constant current source to prevent damage. Since most common power supplies are (nearly) constant-voltage sources, LED fixtures must include a power converter, or at least a current-limiting resistor. In some applications, the internal resistance of small batteries is sufficient to keep current within the LED rating.^[*citation needed*]

LEDs are sensitive to voltage. They must be supplied with a voltage above their threshold voltage and a current below their rating. Current and lifetime change greatly with a small change in applied voltage. They thus require a current-regulated supply (usually just a series resistor for indicator LEDs).^[65]

Efficiency droop: The efficiency of LEDs decreases as the electric current increases. Heating also increases with higher currents, which compromises LED lifetime. These effects put practical limits on the current through an LED in high power applications.^[66]

Electrical polarity

[edit]

Main article: Electrical polarity of LEDs

Unlike a traditional incandescent lamp, an LED will light only when voltage is applied in the forward direction of the diode. No current flows and no light is emitted if voltage is applied in

the reverse direction. If the reverse voltage exceeds the breakdown voltage, which is typically about five volts, a large current flows and the LED will be damaged. If the reverse current is sufficiently limited to avoid damage, the reverse-conducting LED is a useful noise diode.^[citation needed]

By definition, the energy band gap of any diode is higher when reverse-biased than when forward-biased. Because the band gap energy determines the wavelength of the light emitted, the color cannot be the same when reverse-biased. The reverse breakdown voltage is sufficiently high that the emitted wavelength cannot be similar enough to still be visible. Though dual-LED packages exist that contain a different color LED in each direction, it is not expected that any single LED element can emit visible light when reverse-biased.^[citation needed]

It is not known if any zener diode could exist that emits light only in reverse-bias mode. Uniquely, this type of LED would conduct when connected backwards.

Appearance

[edit]

- Color: LEDs can emit light of an intended color without using any color filters as traditional lighting methods need. This is more efficient and can lower initial costs.
- Cool light: In contrast to most light sources, LEDs radiate very little heat in the form of IR that can cause damage to sensitive objects or fabrics. Wasted energy is dispersed as heat through the base of the LED.
- Color rendition: Most cool-white LEDs have spectra that differ significantly from a black body radiator like the sun or an incandescent light. The spike at 460 nm and dip at 500 nm can make the color of objects appear differently under cool-white LED illumination than sunlight or incandescent sources, due to metamerism,^[67] red surfaces being rendered particularly poorly by typical phosphor-based cool-white LEDs. The same is true with green surfaces. The quality of color rendition of an LED is measured by the Color Rendering Index (CRI).
- Dimming: LEDs can be dimmed either by pulse-width modulation or lowering the forward current.^[68] This pulse-width modulation is why LED lights, particularly headlights on cars, when viewed on camera or by some people, seem to flash or flicker. This is a type of stroboscopic effect.

Light properties

[edit]

- Switch on time: LEDs light up extremely quickly. A typical red indicator LED achieves full brightness in under a microsecond.^[69] LEDs used in communications devices can have even faster response times.
- Focus: The solid package of the LED can be designed to focus its light. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner. For larger LED packages total internal reflection (TIR) lenses are often used to the same effect. When large quantities of light are needed, many light

sources such as LED chips are usually deployed, which are difficult to focus or collimate on the same target.

- Area light source: Single LEDs do not approximate a point source of light giving a spherical light distribution, but rather a lambertian distribution. So, LEDs are difficult to apply to uses needing a spherical light field. Different fields of light can be manipulated by the application of different optics or "lenses". LEDs cannot provide divergence below a few degrees.[⁷⁰]

Reliability

[edit]

- Shock resistance: LEDs, being solid-state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs, which are fragile.[⁷¹]
- Thermal runaway: Parallel strings of LEDs will not share current evenly due to the manufacturing tolerances in their forward voltage. Running two or more strings from a single current source may result in LED failure as the devices warm up. If forward voltage binning is not possible, a circuit is required to ensure even distribution of current between parallel strands.[⁷²]
- Slow failure: LEDs mainly fail by dimming over time, rather than the abrupt failure of incandescent bulbs.[⁷³]
- Lifetime: LEDs can have a relatively long useful life. One report estimates 35,000 to 50,000 hours of useful life, though time to complete failure may be shorter or longer.[⁷⁴] Fluorescent tubes typically are rated at about 10,000 to 25,000 hours, depending partly on the conditions of use, and incandescent light bulbs at 1,000 to 2,000 hours. Several DOE demonstrations have shown that reduced maintenance costs from this extended lifetime, rather than energy savings, is the primary factor in determining the payback period for an LED product.[⁷⁵]
- Cycling: LEDs are ideal for uses subject to frequent on-off cycling, unlike incandescent and fluorescent lamps that fail faster when cycled often, or high-intensity discharge lamps (HID lamps) that require a long time to warm up to full output and to cool down before they can be lighted again if they are being restarted.
- Temperature dependence: LED performance largely depends on the ambient temperature of the operating environment – or thermal management properties. Overdriving an LED in high ambient temperatures may result in overheating the LED package, eventually leading to device failure. An adequate heat sink is needed to maintain long life. This is especially important in automotive, medical, and military uses where devices must operate over a wide range of temperatures, and require low failure rates.

Manufacturing

[edit]

LED manufacturing involves multiple steps, including epitaxy, chip processing, chip separation, and packaging.[⁷⁶]

In a typical LED manufacturing process, encapsulation is performed after probing, dicing, die transfer from wafer to package, and wire bonding or flip chip mounting,^[77] perhaps using indium tin oxide, a transparent electrical conductor. In this case, the bond wire(s) are attached to the ITO film that has been deposited in the LEDs.

Flip chip circuit on board (COB) is a technique that can be used to manufacture LEDs.^[78]

Colors and materials

[edit]

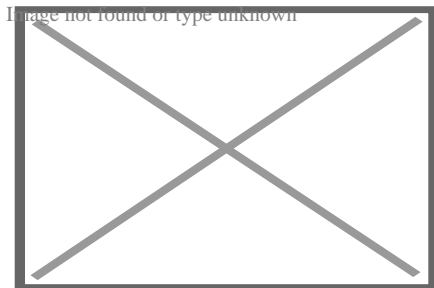
Conventional LEDs are made from a variety of inorganic semiconductor materials. The following table shows the available colors with wavelength range, voltage drop and material:

	Color	Wavelength (nm)	Voltage (V)	Semiconductor material
	Infrared	? > 760	? V < 1.9	Gallium arsenide (GaAs) Aluminium gallium arsenide (AlGaAs)
	Red	610 < ? < 760	1.63 < ? V < 2.03	Aluminium gallium arsenide (AlGaAs) Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium(III) phosphide (GaP)
	Orange	590 < ? < 610	2.03 < ? V < 2.10	Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium(III) phosphide (GaP)
	Yellow	570 < ? < 590	2.10 < ? V < 2.18	Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium(III) phosphide (GaP)
	Green	500 < ? < 570	1.9 ^[79] < ? V < 4.0	Indium gallium nitride (InGaN) / Gallium(III) nitride (GaN) Gallium(III) phosphide (GaP) Aluminium gallium indium phosphide (AlGaInP) Aluminium gallium phosphide (AlGaP)

Blue	$450 < \lambda < 500$	$2.48 < V < 3.7$	Zinc selenide (ZnSe) Indium gallium nitride (InGaN) Silicon carbide (SiC) as substrate Silicon (Si) as substrate — (under development)
Violet	$400 < \lambda < 450$	$2.76 < V < 4.0$	Indium gallium nitride (InGaN)
Purple	multiple types	$2.48 < V < 3.7$	Dual blue/red LEDs, blue with red phosphor, or white with purple plastic
Ultraviolet	$\lambda < 400$	$3.1 < V < 4.4$	Diamond (235 nm) ^[80] Boron nitride (215 nm) ^[81] ^[82] Aluminium nitride (AlN) (210 nm) ^[16] Aluminium gallium nitride (AlGaN) Aluminium gallium indium nitride (AlGaInN) — (down to 210 nm) ^[83]
White	Broad spectrum	$2.7 < V < 3.5$	Blue diode with yellow phosphor or violet/UV diode with multi-color phosphor

Applications

[edit]



Daytime running light LEDs of an automobile

LED uses fall into five major categories:

- Visual signals where light goes more or less directly from the source to the human eye, to convey a message or meaning
- Illumination where light is reflected from objects to give visual response of these objects
- Measuring and interacting with processes involving no human vision^[84]

- Narrow band light sensors where LEDs operate in a reverse-bias mode and respond to incident light, instead of emitting light.^{[85][86][87][88]}
- Indoor cultivation, including cannabis.^[89]

The application of LEDs in horticulture has revolutionized plant cultivation by providing energy-efficient, customizable lighting solutions that optimize plant growth and development.^[90] LEDs offer precise control over light spectra, intensity, and photoperiods, enabling growers to tailor lighting conditions to the specific needs of different plant species and growth stages. This technology enhances photosynthesis, improves crop yields, and reduces energy costs compared to traditional lighting systems. Additionally, LEDs generate less heat, allowing closer placement to plants without risking thermal damage, and contribute to sustainable farming practices by lowering carbon footprints and extending growing seasons in controlled environments.^[91] Light spectrum affects growth, metabolite profile, and resistance against fungal phytopathogens of *Solanum lycopersicum* seedlings.^[92] LEDs can also be used in micropropagation.^[93]

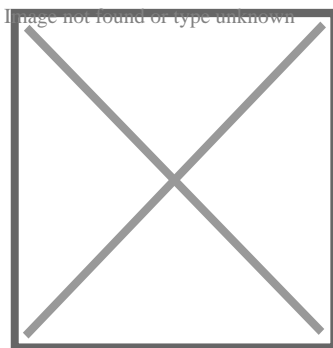
Indicators and signs

[edit]



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The low energy consumption, low maintenance and small size of LEDs has led to uses as status indicators and displays on a variety of equipment and installations. Large-area LED displays are used as stadium displays, dynamic decorative displays, and dynamic message signs on freeways. Thin, lightweight message displays are used at airports and railway stations, and as destination displays for trains, buses, trams, and ferries.



Red and green LED traffic signals

One-color light is well suited for traffic lights and signals, exit signs, emergency vehicle lighting, ships' navigation lights, and LED-based Christmas lights

Because of their long life, fast switching times, and visibility in broad daylight due to their high output and focus, LEDs have been used in automotive brake lights and turn signals.

The use in brakes improves safety, due to a great reduction in the time needed to light fully, or faster rise time, about 0.1 second faster^[citation needed] than an incandescent bulb. This gives drivers behind more time to react. In a dual intensity circuit (rear markers and brakes) if the LEDs are not pulsed at a fast enough frequency, they can create a phantom array, where ghost images of the LED appear if the eyes quickly scan across the array. White LED headlamps are beginning to appear. Using LEDs has styling advantages because LEDs can form much thinner lights than incandescent lamps with parabolic reflectors.

Due to the relative cheapness of low output LEDs, they are also used in many temporary uses such as glowsticks and throwies. Artists have also used LEDs for LED art.

Lighting

[edit]

Main article: LED lamp

With the development of high-efficiency and high-power LEDs, it has become possible to use LEDs in lighting and illumination. To encourage the shift to LED lamps and other high-efficiency lighting, in 2008 the US Department of Energy created the L Prize competition. The Philips Lighting North America LED bulb won the first competition on August 3, 2011, after successfully completing 18 months of intensive field, lab, and product testing.^[94]

Efficient lighting is needed for sustainable architecture. As of 2011, some LED bulbs provide up to 150 lm/W and even inexpensive low-end models typically exceed 50 lm/W, so that a 6-watt LED could achieve the same results as a standard 40-watt incandescent bulb. The lower heat output of LEDs also reduces demand on air conditioning systems. Worldwide, LEDs are rapidly adopted to displace less effective sources such as incandescent lamps and CFLs and reduce electrical energy consumption and its associated emissions. Solar powered LEDs are used as street lights and in architectural lighting.

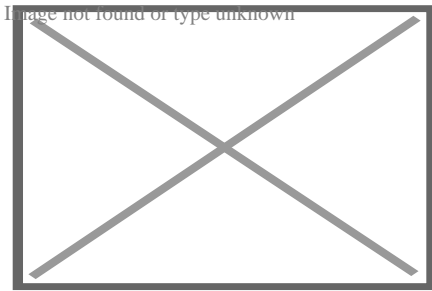
The mechanical robustness and long lifetime are used in automotive lighting on cars, motorcycles, and bicycle lights. LED street lights are employed on poles and in parking garages. In 2007, the Italian village of Torraca was the first place to convert its street lighting to LEDs.^[95]

Cabin lighting on recent^[when?] Airbus and Boeing jetliners uses LED lighting. LEDs are also being used in airport and heliport lighting. LED airport fixtures currently include medium-intensity runway lights, runway centerline lights, taxiway centerline and edge lights, guidance signs, and obstruction lighting.

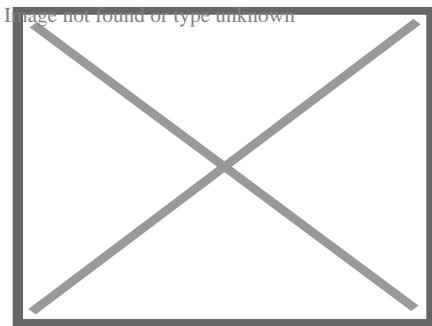
LEDs are also used as a light source for DLP projectors, and to backlight newer LCD television (referred to as LED TV), computer monitor (including laptop) and handheld device LCDs, succeeding older CCFL-backlit LCDs although being superseded by OLED screens. RGB LEDs raise the color gamut by as much as 45%. Screens for TV and computer displays can be made thinner using LEDs for backlighting.^[96]

LEDs are small, durable and need little power, so they are used in handheld devices such as flashlights. LED strobe lights or camera flashes operate at a safe, low voltage, instead of the 250+ volts commonly found in xenon flashlamp-based lighting. This is especially useful in cameras on mobile phones, where space is at a premium and bulky voltage-raising circuitry is undesirable.

LEDs are used for infrared illumination in night vision uses including security cameras. A ring of LEDs around a video camera, aimed forward into a retroreflective background, allows chroma keying in video productions.



LED for miners, to increase visibility inside mines



Los Angeles Vincent Thomas Bridge illuminated with blue LEDs

LEDs are used in mining operations, as cap lamps to provide light for miners. Research has been done to improve LEDs for mining, to reduce glare and to increase illumination, reducing risk of injury to the miners.^[97]

LEDs are increasingly finding uses in medical and educational applications, for example as mood enhancement.^[98] NASA has even sponsored research for the use of LEDs to promote health for astronauts.^[99]

Data communication and other signalling

[edit]

See also: Li-Fi, fibre optics, Visible light communication, and Optical disc

Light can be used to transmit data and analog signals. For example, lighting white LEDs can be used in systems assisting people to navigate in closed spaces while searching necessary rooms or objects.^[100]

Assistive listening devices in many theaters and similar spaces use arrays of infrared LEDs to send sound to listeners' receivers. Light-emitting diodes (as well as semiconductor lasers) are used to send data over many types of fiber optic cable, from digital audio over TOSLINK cables to the very high bandwidth fiber links that form the Internet backbone. For some time, computers were commonly equipped with IrDA interfaces, which allowed them to send and receive data to nearby machines via infrared.

Because LEDs can cycle on and off millions of times per second, very high data bandwidth can be achieved.^[101] For that reason, visible light communication (VLC) has been proposed as an alternative to the increasingly competitive radio bandwidth.^[102] VLC operates in the visible part of the electromagnetic spectrum, so data can be transmitted without occupying the frequencies of radio communications.

Machine vision systems

[edit]

Main article: Machine vision

Machine vision systems often require bright and homogeneous illumination, so features of interest are easier to process. LEDs are often used.

Barcode scanners are the most common example of machine vision applications, and many of those scanners use red LEDs instead of lasers. Optical computer mice use LEDs as a light source for the miniature camera within the mouse.

LEDs are useful for machine vision because they provide a compact, reliable source of light. LED lamps can be turned on and off to suit the needs of the vision system, and the shape of the beam produced can be tailored to match the system's requirements.

Biological detection

[edit]

The discovery of radiative recombination in aluminum gallium nitride (AlGaIn) alloys by U.S. Army Research Laboratory (ARL) led to the conceptualization of UV light-emitting diodes (LEDs) to be incorporated in light-induced fluorescence sensors used for biological agent detection.^[103]^[104]^[105] In 2004, the Edgewood Chemical Biological Center (ECBC) initiated the effort to create a biological detector named TAC-BIO. The program capitalized on semiconductor UV optical sources (SUVOS) developed by the Defense Advanced Research Projects Agency (DARPA).^[105]

UV-induced fluorescence is one of the most robust techniques used for rapid real-time detection of biological aerosols.^[105] The first UV sensors were lasers lacking in-field-use practicality. In order to address this, DARPA incorporated SUVOS technology to create a low-cost, small, lightweight, low-power device. The TAC-BIO detector's response time was

one minute from when it sensed a biological agent. It was also demonstrated that the detector could be operated unattended indoors and outdoors for weeks at a time.[¹⁰⁵]

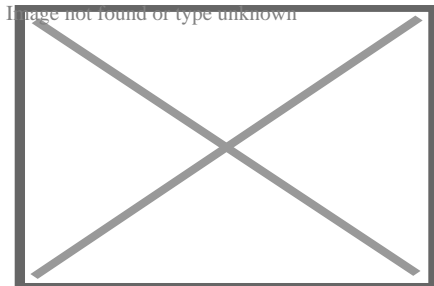
Aerosolized biological particles fluoresce and scatter light under a UV light beam. Observed fluorescence is dependent on the applied wavelength and the biochemical fluorophores within the biological agent. UV induced fluorescence offers a rapid, accurate, efficient and logistically practical way for biological agent detection. This is because the use of UV fluorescence is reagentless, or a process that does not require an added chemical to produce a reaction, with no consumables, or produces no chemical byproducts.[¹⁰⁵]

Additionally, TAC-BIO can reliably discriminate between threat and non-threat aerosols. It was claimed to be sensitive enough to detect low concentrations, but not so sensitive that it would cause false positives. The particle-counting algorithm used in the device converted raw data into information by counting the photon pulses per unit of time from the fluorescence and scattering detectors, and comparing the value to a set threshold.[¹⁰⁶]

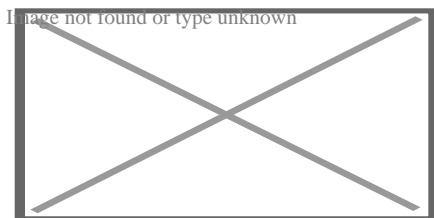
The original TAC-BIO was introduced in 2010, while the second-generation TAC-BIO GEN II, was designed in 2015 to be more cost-efficient, as plastic parts were used. Its small, light-weight design allows it to be mounted to vehicles, robots, and unmanned aerial vehicles. The second-generation device could also be utilized as an environmental detector to monitor air quality in hospitals, airplanes, or even in households to detect fungus and mold.[¹⁰⁷][¹⁰⁸]

Other applications

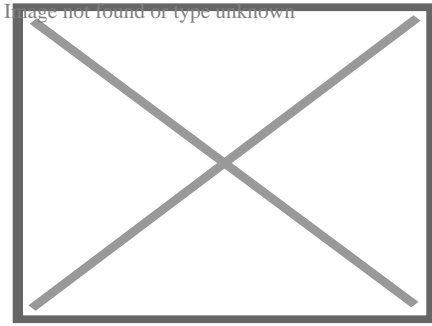
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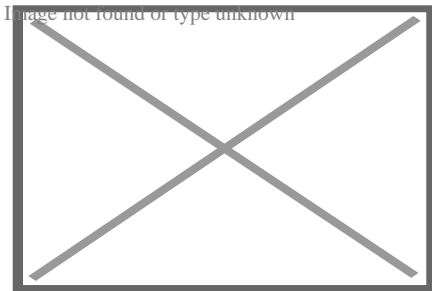
LED costume for stage performers



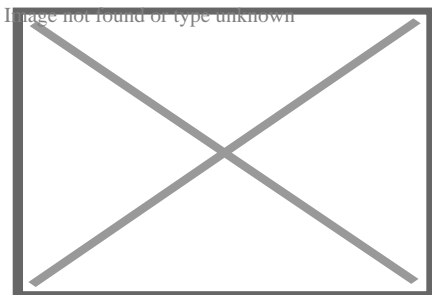
LED wallpaper by Meystyle



A large LED display behind a disc jockey



Seven-segment display that can display four digits and points



LED panel light source used in an early experiment on potato growth during Shuttle mission STS-73 to investigate the potential for growing food on future long duration missions

The light from LEDs can be modulated very quickly so they are used extensively in optical fiber and free space optics communications. This includes remote controls, such as for television sets, where infrared LEDs are often used. Opto-isolators use an LED combined with a photodiode or phototransistor to provide a signal path with electrical isolation between two circuits. This is especially useful in medical equipment where the signals from a low-voltage sensor circuit (usually battery-powered) in contact with a living organism must be electrically isolated from any possible electrical failure in a recording or monitoring device operating at potentially dangerous voltages. An optoisolator also lets information be transferred between circuits that do not share a common ground potential.

Many sensor systems rely on light as the signal source. LEDs are often ideal as a light source due to the requirements of the sensors. The Nintendo Wii's sensor bar uses infrared LEDs. Pulse oximeters use them for measuring oxygen saturation. Some flatbed scanners use arrays of RGB LEDs rather than the typical cold-cathode fluorescent lamp as the light

source. Having independent control of three illuminated colors allows the scanner to calibrate itself for more accurate color balance, and there is no need for warm-up. Further, its sensors only need be monochromatic, since at any one time the page being scanned is only lit by one color of light.

Since LEDs can also be used as photodiodes, they can be used for both photo emission and detection. This could be used, for example, in a touchscreen that registers reflected light from a finger or stylus.^[109] Many materials and biological systems are sensitive to, or dependent on, light. Grow lights use LEDs to increase photosynthesis in plants,^[110] and bacteria and viruses can be removed from water and other substances using UV LEDs for sterilization.^[15] LEDs of certain wavelengths have also been used for light therapy treatment of neonatal jaundice and acne.^[111]

UV LEDs, with spectra range of 220 nm to 395 nm, have other applications, such as water/air purification, surface disinfection, glue curing, free-space non-line-of-sight communication, high performance liquid chromatography, UV curing dye printing, phototherapy (295nm Vitamin D, 308nm Excimer lamp or laser replacement), medical/ analytical instrumentation, and DNA absorption.^{[104][112]}

LEDs have also been used as a medium-quality voltage reference in electronic circuits. The forward voltage drop (about 1.7 V for a red LED or 1.2V for an infrared) can be used instead of a Zener diode in low-voltage regulators. Red LEDs have the flattest I/V curve above the knee. Nitride-based LEDs have a fairly steep I/V curve and are useless for this purpose. Although LED forward voltage is far more current-dependent than a Zener diode, Zener diodes with breakdown voltages below 3 V are not widely available.

The progressive miniaturization of low-voltage lighting technology, such as LEDs and OLEDs, suitable to incorporate into low-thickness materials has fostered experimentation in combining light sources and wall covering surfaces for interior walls in the form of LED wallpaper.

Research and development

[edit]

Key challenges

[edit]

LEDs require optimized efficiency to hinge on ongoing improvements such as phosphor materials and quantum dots.^[113]

The process of down-conversion (the method by which materials convert more-energetic photons to different, less energetic colors) also needs improvement. For example, the red phosphors that are used today are thermally sensitive and need to be improved in that aspect so that they do not color shift and experience efficiency drop-off with temperature.

Red phosphors could also benefit from a narrower spectral width to emit more lumens and becoming more efficient at converting photons.[¹¹⁴]

In addition, work remains to be done in the realms of current efficiency droop, color shift, system reliability, light distribution, dimming, thermal management, and power supply performance.[¹¹³]

Early suspicions were that the LED droop was caused by elevated temperatures. Scientists showed that temperature was not the root cause of efficiency droop.[¹¹⁵] The mechanism causing efficiency droop was identified in 2007 as Auger recombination, which was taken with mixed reaction.[⁶⁶] A 2013 study conclusively identified Auger recombination as the cause.[¹¹⁶]

Potential technology

[edit]

A new family of LEDs are based on the semiconductors called perovskites. In 2018, less than four years after their discovery, the ability of perovskite LEDs (PLEDs) to produce light from electrons already rivaled those of the best performing OLEDs.[¹¹⁷] They have a potential for cost-effectiveness as they can be processed from solution, a low-cost and low-tech method, which might allow perovskite-based devices that have large areas to be made with extremely low cost. Their efficiency is superior by eliminating non-radiative losses, in other words, elimination of recombination pathways that do not produce photons; or by solving outcoupling problem (prevalent for thin-film LEDs) or balancing charge carrier injection to increase the EQE (external quantum efficiency). The most up-to-date PLED devices have broken the performance barrier by shooting the EQE above 20%.[¹¹⁸]

In 2018, Cao et al. and Lin et al. independently published two papers on developing perovskite LEDs with EQE greater than 20%, which made these two papers a mile-stone in PLED development. Their device have similar planar structure, i.e. the active layer (perovskite) is sandwiched between two electrodes. To achieve a high EQE, they not only reduced non-radiative recombination, but also utilized their own, subtly different methods to improve the EQE.[¹¹⁸]

In the work of Cao *et al.*, [¹¹⁹] researchers targeted the outcoupling problem, which is that the optical physics of thin-film LEDs causes the majority of light generated by the semiconductor to be trapped in the device.[¹²⁰] To achieve this goal, they demonstrated that solution-processed perovskites can spontaneously form submicrometre-scale crystal platelets, which can efficiently extract light from the device. These perovskites are formed via the introduction of amino acid additives into the perovskite precursor solutions. In addition, their method is able to passivate perovskite surface defects and reduce nonradiative recombination. Therefore, by improving the light outcoupling and reducing nonradiative losses, Cao and his colleagues successfully achieved PLED with EQE up to 20.7%.[¹¹⁹]

Lin and his colleague used a different approach to generate high EQE. Instead of modifying the microstructure of perovskite layer, they chose to adopt a new strategy for managing the compositional distribution in the device—an approach that simultaneously provides high luminescence and balanced charge injection. In other words, they still used flat emissive layer, but tried to optimize the balance of electrons and holes injected into the perovskite, so as to make the most efficient use of the charge carriers. Moreover, in the perovskite layer, the crystals are perfectly enclosed by MABr additive (where MA is CH_3NH_3). The MABr shell passivates the nonradiative defects that would otherwise be present perovskite crystals, resulting in reduction of the nonradiative recombination. Therefore, by balancing charge injection and decreasing nonradiative losses, Lin and his colleagues developed PLED with EQE up to 20.3%.^[121]

Health and safety

[edit]

Certain blue LEDs and cool-white LEDs can exceed safe limits of the so-called blue-light hazard as defined in eye safety specifications such as "ANSI/IESNA RP-27.1–05: Recommended Practice for Photobiological Safety for Lamp and Lamp Systems".^[122] One study showed no evidence of a risk in normal use at domestic illuminance,^[123] and that caution is only needed for particular occupational situations or for specific populations.^[124] In 2006, the International Electrotechnical Commission published *IEC 62471 Photobiological safety of lamps and lamp systems*, replacing the application of early laser-oriented standards for classification of LED sources.^[125]

While LEDs have the advantage over fluorescent lamps, in that they do not contain mercury, they may contain other hazardous metals such as lead and arsenic.^[126]

In 2016 the American Medical Association (AMA) issued a statement concerning the possible adverse influence of blueish street lighting on the sleep-wake cycle of city-dwellers. Critics in the industry claim exposure levels are not high enough to have a noticeable effect.^[127]

Environmental issues



[edit]

- Light pollution: Because white LEDs emit more short wavelength light than sources such as high-pressure sodium vapor lamps, the increased blue and green sensitivity of scotopic vision means that white LEDs used in outdoor lighting cause substantially more sky glow.^[55]
- Impact on wildlife: LEDs are much more attractive to insects than sodium-vapor lights, so much so that there has been speculative concern about the possibility of disruption to food webs.^{[128][129]} LED lighting near beaches, particularly intense blue and white colors, can disorient turtle hatchlings and make them wander inland instead.^[130] The use of "turtle-safe lighting" LEDs that emit only at narrow portions of the visible spectrum is encouraged by conservancy groups in order to reduce harm.^[131]

- Use in winter conditions: Since they do not give off much heat in comparison to incandescent lights, LED lights used for traffic control can have snow obscuring them, leading to accidents.^[132]^[133]

See also

[edit]

-  Electronics portal
-  Energy portal
- LED tattoo
- High-CRI LED lighting
- List of light sources
- MicroLED
- Superluminescent diode
- Perovskite light-emitting diode

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External links

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Wikimedia Commons has media related to ***Light-emitting diodes*** and ***Light-emitting diodes (SMD)***.

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- Building a do-it-yourself LED
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Lighting

Concepts

- Accent lighting
- Color rendering index
- Color temperature
- Electric light
- Glare
- Light fixture
- Light pollution
 - Hawaii
 - Hong Kong
- Lightbulb socket
 - Bi-pin lamp base
 - Edison screw
- Luminous efficacy
- Task lighting

Methods of generation

- Incandescent
 - Regular
 - Edison
 - Halogen
 - Nernst
 - Cathodoluminescent
 - Electron-stimulated
 - Chemiluminescent
 - Electrochemiluminescence
 - Electroluminescent
 - field-induced polymer
- Luminescent
 - Fluorescent
 - Fluorescent lamp (compact)
 - Fluorescent induction
 - Photoluminescent
 - Laser headlamp
 - Radioluminescence
 - Solid-state
 - LED lamp
 - Acetylene/Carbide
 - Argand
 - Campfire
 - Candle
 - Carcel
 - Diya
 - Flare
 - Gas
 - Kerosene
 - Petromax
- Combustion
 - Lantern
 - Fanous
 - Paper
 - Limelight
 - Luchina
 - Magnesium torch
 - Oil
 - Qulliq
 - Rushlight
 - Safety
 - Tilley
 - Torch
- Electric arc
 - Carbon arc
 - Klieg light
 - Yablochkov candle
 - Deuterium arc
 - Neon
 - Neon lamp
- Gas discharge
 - Plasma
 - Sulfur
 - Xenon arc

Stationary

- Reflector
 - Ellipsoidal reflector
 - Multifaceted reflector
 - Parabolic aluminized reflector (PAR)
- Aviation obstruction
- Balanced-arm lamp
- Chandelier
- Emergency light
- Gas lighting
- Gooseneck lamp
- Intelligent street lighting
- Light tube
- Nightlight
- Neon lighting
- Pendant light
- Recessed light
- Sconce
- Street light
 - in the US
- Torchère
- Track lighting
- Troffer
- Bicycle lighting
- Flashlight
 - Mechanically powered
 - Tactical
- Glow stick
- Headlamp
 - outdoor
- Lantern
- Laser pointer
- Navigation light
- Searchlight
- Solar lamp

Portable

- Automotive light bulb types
- Daytime running lamp
- Headlamp
 - hidden
 - high-intensity discharge
 - sealed beam
- Automotive**
- Rear position lights
- Reversing lights
- Safety reflector
 - retroreflector
- Stop lights
- Turn signals
 - trafficators
- Aroma lamp
- Blacklight
- Bubble light
- Christmas lights
- Crackle tube
- DJ lighting
- Electroluminescent wire
- Lava lamp
- Marquee
- Plasma globe
- Strobe light
- Floodlight
- Footlight
- Gobo
- Scoop
- Spotlight
 - ellipsoidal reflector
- Stage lighting instrument
- Germicidal
- Grow light
- Infrared lamp
- Stroboscope
- Tanning
- Battlefield illumination
- Bioluminescence
- Laser
- Light art
- Luminous gemstones
- Signal lamp
- Sources
 - Reflected
- **Display**
- **Decorative**
- **Theatrical**
- **Cinematic**
- **Industrial**
- **Scientific**
- Related topics**

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Display technology

- | | | |
|------------------------------|----------------------------------|--|
| | <p>Past generation</p> | <ul style="list-style-type: none"> o Eidophor o Cathode-ray tube (CRT) o Jumbotron o Electroluminescent display (ELD) o Rear-projection display o Plasma display panel (PDP) <ul style="list-style-type: none"> o ALiS o Quantum dot display (QLED) o Electronic paper <ul style="list-style-type: none"> o E Ink o Gyricon o Light-emitting diode display (LED) <ul style="list-style-type: none"> o Organic light-emitting diode (OLED) <ul style="list-style-type: none"> o Active-Matrix Organic light-emitting diode (AMOLED) |
| <p>Video displays</p> | <p>Current generation</p> | <ul style="list-style-type: none"> o Liquid-crystal display (LCD) <ul style="list-style-type: none"> o TFT <ul style="list-style-type: none"> o TN o IPS o LED-backlit <ul style="list-style-type: none"> o Blue Phase o Digital Light Processing (DLP) o Liquid crystal on silicon (LCoS) o microLED o Electroluminescent Quantum Dots (ELQD/QD-LED) o Organic light-emitting transistor (OLET) o Surface-conduction electron-emitter display (SED) o Field-emission display (FED) o Laser TV <ul style="list-style-type: none"> o Quantum dot o Liquid crystal |
| | <p>Next generation</p> | <ul style="list-style-type: none"> o MEMS display <ul style="list-style-type: none"> o IMoD o TMOS o Ferroelectric liquid crystal display (FLCD) o Thick-film dielectric electroluminescent technology (TDEL) o Laser-powered phosphor display (LPD) |

- Electromechanical
 - Flip-dot
 - Split-flap
- Eggcrate
- Fiber-optic
- Nixie tube
- Vacuum fluorescent display (VFD)
- Non-video**
 - Light-emitting electrochemical cell (LEC)
 - Lightguide display
 - Dot-matrix display
 - Seven-segment display (SSD)
 - Eight-segment display
 - Nine-segment display
 - Fourteen-segment display (FSD)
 - Sixteen-segment display (SISD)
 - Stereoscopic
 - Autostereoscopic
 - Multiscopic
- 3D display**
 - Hologram
 - Holographic display
 - Computer-generated holography
 - Volumetric
 - Fog display
 - Monoscope
 - Movie projector
- Static media**
 - Neon sign
 - Slide projector
 - Transparency
 - Laser beam
 - EDID
 - CEA-861
- Display capabilities**
 - DisplayID
 - Always-on display
 - See-through display
 - Scan line
 - History of display technology
 - Large-screen television technology
- Related articles**
 - Optimum HDTV viewing distance
 - High Dynamic Range (HDR)
 - Color Light Output
 - Flexible display
 - Comparison of CRT, LCD, plasma, and OLED displays
- Comparison of display technology

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Electronic components

- Transistor
 - NMOS
 - PMOS
 - BiCMOS
 - BioFET
 - Chemical field-effect transistor (ChemFET)
 - Complementary MOS (CMOS)
 - Depletion-load NMOS
 - Fin field-effect transistor (FinFET)
 - Floating-gate MOSFET (FGMOS)
 - Insulated-gate bipolar transistor (IGBT)
 - ISFET
 - LDMOS
 - MOS field-effect transistor (MOSFET)
 - Multi-gate field-effect transistor (MuGFET)
 - Power MOSFET
 - Thin-film transistor (TFT)
 - VMOS
 - UMOS
 - Bipolar junction transistor (BJT)
 - Darlington transistor
 - Diffused junction transistor
 - Field-effect transistor (FET)
 - Junction Gate FET (JFET)
 - Organic FET (OFET)
 - Light-emitting transistor (LET)
 - Organic LET (OLET)
 - Pentode transistor
 - Point-contact transistor
 - Programmable unijunction transistor (PUT)
 - Static induction transistor (SIT)
 - Tetrode transistor
 - Unijunction transistor (UJT)
 - Avalanche diode
 - Constant-current diode (CLD, CRD)
 - Gunn diode
 - Laser diode (LD)
 - Light-emitting diode (LED)
 - Organic light-emitting diode (OLED)
 - Photodiode
 - PIN diode
 - Schottky diode
 - Step recovery diode
 - Zener diode
 - Printed electronics
 - Printed circuit board
 - DIAC
 - Heterostructure barrier varactor
 - Integrated circuit (IC)
- MOS transistors**
- Other transistors**
- Semiconductor devices**
- Diodes**

Voltage regulators

- Linear regulator
- Low-dropout regulator
- Switching regulator
- Buck
- Boost
- Buck–boost
- Split-pi
- Ā,,â€ uk
- SEPIC
- Charge pump
- Switched capacitor

Vacuum tubes

- Acorn tube
- Audion
- Beam tetrode
- Barretter
- Compactron
- Diode
- Fleming valve
- Neutron tube
- Nonode
- Nuvistor
- Pentagrid (Hexode, Heptode, Octode)
- Pentode
- Photomultiplier
- Phototube
- Tetrode
- Triode
- Backward-wave oscillator (BWO)
- Cavity magnetron
- Crossed-field amplifier (CFA)
- Gyrotron

Vacuum tubes (RF)

- Inductive output tube (IOT)
- Klystron
- Maser
- Sutton tube
- Traveling-wave tube (TWT)
- X-ray tube

Cathode-ray tubes

- Beam deflection tube
- Charactron
- Iconoscope
- Magic eye tube
- Monoscope
- Selectron tube
- Storage tube
- Trochotron
- Video camera tube
- Williams tube
- Cold cathode
- Crossatron
- Dekatron
- Ignitron
- Krytron

Gas-filled tubes

- Mercury-arc valve
- Neon lamp
- Nixie tube
- Thyatron
- Trigatron
- Voltage-regulator tube
- Potentiometer

Adjustable

- digital
- Variable capacitor
- Varicap
- Connector
 - audio and video
 - electrical power
 - RF
- Electrolytic detector
- Ferrite
- Antifuse
- Fuse

Passive

- resettable
- eFUSE
- Resistor
- Switch
- Thermistor
- Transformer
- Varistor
- Wire
 - Wollaston wire

Reactive

- Capacitor
 - types
- Ceramic resonator
- Crystal oscillator
- Inductor
- Parametron
- Relay
 - reed relay
 - mercury relay

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About Overhead Door Company of Joliet

Photo



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Things To Do in Will County

Photo

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Des Plaines River viewing point

5 (1)

Photo

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Lincoln Landing

4.6 (134)

Photo

Gemini Giant

3.4 (26)

Photo

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Lake Renwick Heron Rookery Nature Preserve

4.6 (87)

Photo

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Route 66 Experience Sign

3.7 (3)

Photo

Route 66 Park

4.3 (435)

Photo

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Old Joliet Prison

4.6 (1759)

Driving Directions in Will County

Driving Directions From Al's Steak House Restaurant to Overhead Door Company of Joliet

Driving Directions From Honorable Robert Brumund to Overhead Door Company of Joliet

Driving Directions From Dollar General to Overhead Door Company of Joliet

https://www.google.com/maps/dir/Honorable+Robert+Brumund/Overhead+Door+Company+of+Joliet,+Illinois/88.0822783,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sChIJ4ykaz7dmDogRZvLfvijRz88.0822783!2d41.5244092!1m5!1m1!1sChIJLWV_oV9hDogRGyjUaaoTEjk!2m2!1d-88.106331!2d41.5069115!3e0

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Driving Directions From Pilcher Park Nature Center to Overhead Door Company of Joliet

Driving Directions From Gemini Giant to Overhead Door Company of Joliet

Driving Directions From Illinois State Museum-Lockport Gallery to Overhead Door Company of Joliet

Driving Directions From Fox Museum to Overhead Door Company of Joliet

Driving Directions From Isle A La Cache Museum Pavilion to Overhead Door Company of Joliet

Driving Directions From Lockport Prairie Nature Preserve to Overhead Door Company of Joliet

Driving Directions From Will County Historical Museum and Research Center to Overhead Door Company of Joliet

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Reviews for Overhead Door Company of Joliet

Overhead Door Company of Joliet

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Kelley Jansa

(5)

We used Middleton Door to upgrade our garage door. We had three different companies come out to quote the job and across the board Middleton was better. They were professional, had plenty of different options and priced appropriately. The door we ordered came with a small dent and they handled getting a new panel ordered and reinstalled very quickly.

Overhead Door Company of Joliet

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Andrea Nitsche

(4)

Scheduling was easy, job was done quickly. Little disappointed that they gave me a quote over email (which they confirmed was for labor and materials), but when they finished it was just over \$30 more. Not a huge deal, but when I asked why, I was told they gave me an approx cost and it depends on what is needed. I get that in general, however, they installed the door and I gave them my address and pics of the existing prior to getting a quote. I feel like they could have been more upfront with pricing. And just a heads up, it was pricey... Had them change the weather stripping, from ringing my doorbell to pulling out my driveway when done was literally 20 mins, cost was just over \$260 ?

Overhead Door Company of Joliet

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Jim Chuporak

(5)

Received a notice the morning of telling me when to expect the men to come and put the door in. he was on time, answered all my questions, worked diligently in the cold. And did an absolutely awesome job. Everything was cleaned up, hauled away from the old door. I am extremely happy with the service I received from the first phone call I made through having the door put in. My wife and I are very, very happy with the door.

Overhead Door Company of Joliet

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Hector Melero

(5)

Had a really great experience with Middleton Overhead Doors. My door started to bow and after several attempts on me fixing it I just couldn't get it. I didn't want to pay on something I knew I could fix. Well, I gave up and they came out and made it look easy. I know what they are doing not to mention they called me before hand to confirm my appointment and they showed up at there scheduled appointment. I highly recommend Middleton Overhead Doors on any work that needs to be done

Quick Fixes for Sluggish Door Response [View GBP](#)

Check our other pages :

- [Understanding Proper Balance in Garage Door Systems](#)
- [Diagnosing Problems with Door Opener Sensors](#)
- [Understanding Differences in Garage Door Finishes](#)
- [Selecting Weather Resistant Materials for Exterior Conditions](#)

Frequently Asked Questions

What could be causing my garage door to open or close slowly?

A slow-moving garage door can be caused by issues such as lack of lubrication on the tracks, worn-out rollers, incorrect speed settings on the opener, or a weak power supply. Inspect these areas to identify potential problems.

How can I improve the speed of my garage door opener?

To improve the speed, ensure that all moving parts are well-lubricated with a silicone-based lubricant. Check and adjust the speed settings on your garage door opener according to manufacturer instructions. Additionally, inspect and replace any worn-out rollers or springs.

Is it necessary to call a professional if my garage door is sluggish?

While some issues like lubrication and basic adjustments can be handled yourself, its advisable to contact a professional if you encounter complex mechanical problems, electrical issues, or if DIY fixes do not resolve the sluggishness.

Can weather conditions affect my garage doors performance?

Yes, extreme temperatures can cause metal components to contract or expand, impacting movement. Ensure regular maintenance checks during seasonal changes and consider insulating your garage if temperature fluctuations frequently affect performance.

Overhead Door Company of Joliet

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Google Business Profile

Company Website : <https://overheaddoorjoliet.com/garage-door-repair-romeoville.aspx>

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