MILESTONE 19

Bright new world

GETTY

Light-emitting diodes (LEDs) are a ubiquitous part of modern life. Their popularity is evident from their deployment everywhere from car brake lights and giant display boards to traffic lights and indicator lamps on electronic goods. Many also predict that LEDs are poised to play an increasingly important role in interior lighting thanks to their long lifespan and low power consumption.

The origins of the LED can be traced back to the initial research on electroluminescence from semiconductors. In 1907, Henry Round reported a bright glow from a crystal of silicon carbide. This was followed in the 1920s by intensive research by the Russian scientist Oleg Losev, who studied zinc oxide and silicon carbide, observing a threshold behaviour of the light emission and documenting the spectrum of the light emitted.

However, much credit for the invention of a practical LED is widely attributed to scientists in the United States in the early 1960s. In 1961, scientists at Texas Instruments reported that gallium arsenide (GaAs) emitted infrared light when pumped by an electrical current. The following year saw a breakthrough in LED research with various papers on GaAs-based red and infrared light emission, including the report on lasing (MILESTONE 15). Thanks to his pioneering work on red GaAs LEDs, Nick Holonyak is often reported as being 'the father of the LED'.

Although the first versions were dim, LEDs that were much brighter quickly followed, as did yellow emitters. However, for many years scientists struggled to find a suitable material system for emitting bright blue light. This all changed in the 1980s with research on gallium nitride (GaN) and the development by Shuji Nakamura, a scientist at Nichia, of an efficient scheme for positive-type doping (p-doping) of GaN LEDs. His research opened the door to the first commercial high-power blue LEDs in 1993, completing the colour range of LEDs across the visible spectrum. It also led to several important spin-offs including the white LED (a blue LED chip coated with a light-converting phosphor).

In many ways, LEDs can be considered as the first great success of optoelectronics, and improvements in performance have been charted by a law akin to Moore's law in microelectronics. Haitz's law documents that every 10 years the amount of light generated by an LED increases by a factor of 20, whereas the cost per unit of useful light emitted falls by a factor of 10. Today, LED research is flourishing around the world, with scientists attempting to optimize the colour and brightness of white light, push emission deep into the ultraviolet, and explore new efficient material systems based on organic semiconductors as well as quantum dots.

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