then

Evolution of Eyeglasses

The story of eyeglasses is a far-flung tale spanning centuries. Here are a few milestones in the shaping of optical materials to assist human vision.

Tommaso da Modena's portrayal of Cardinal Hugh of Saint-Cher, 1352.

Wikimedia Commons

1100s to 1500s: Emergence of spectacles

One estimate suggests that spectacles first appeared as a visual aid in the early 12th century in the Middle East. Another claims that the eyeglasses were first created in the late 1200s in Italy. Either way, the records show that early "reading aids" used convex lenses to correct both hyperopia and presbyopia. Concave lenses for myopia came later, in the mid-1400s. It was Johannes Kepler (1571–1630) who first correctly described the optics of the eye and its relationship with lenses.

Inexpensive plastics led to fads like "cat-eye" glasses in the 1950s.

Getty Images

1940s: From glass to plastic

For centuries, glass was the primary material for producing eyeglass lenses. However, advances in polymer technology started making waves in optometry, mainly after World War II. First poly(methyl methacrylate) and then acrylic resin were used to make shatterproof and lightweight spectacle lenses. The most widely used is CR-39, which is transparent in the visible wavelength range and almost completely opaque in the UV range.

Grinding a freeform lens.

Zeiss

1981: Freeform for eyeglasses

Bifocals have assisted people with presbyopia since Benjamin Franklin invented these spectacles in 1779. However, the sharp line between the two prescription types in bifocals was distracting to wearers. A design closer to today's progressive bifocals debuted in 1959. Later, in 1981, the mathematician Gerhard Further, working for Carl Zeiss AG, applied freeform-optics techniques to produce progressive lenses and patented the technology.

Beyond Vision Correction

Spectacles have moved beyond their initial role—they can now autofocus, store data and monitor brain waves.

"Smart" glasses can automatically focus on an object.

Adapted from N. Padmanaban et al. Sci. Adv. 5, eaav6187 (2019); CC BY-NC

2019: Autofocusing specs

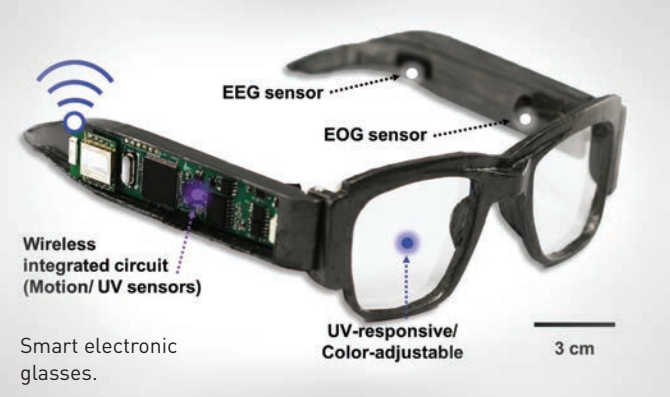
With progressive lenses, the eyeglass-wearers must angle their heads to focus properly on near or far objects. To solve this issue, a research team at Stanford University, USA, developed a software system that, combined with fluid-filled lenses, allows the glasses to autofocus as the object of interest changes. Their prototype "autofocals" were bulky and heavy, but the researchers hope to streamline the system.

ETH Zurich student Julian Koch wearing glasses with lenses that store a short video.

ETH Zurich / J. Venetz

2019: Data storage

Researchers in Switzerland and Israel developed a way to store information in almost any object—including eyeglass lenses. The team used DNA molecules to encode data, and then encapsulated the molecules in silica beads that could be fused into objects. The researchers were able to store a 1.4-Mb video in clear eyeglass lenses—and then read out the video by taking a fragment of the glass and sequencing the embedded DNA.



Smart electronic glasses.

Adapted from ACS Appl. Mater. Interfaces (2020), doi: 10.1021/acsami.0c03110

2020: Smart electronic glasses

Researchers in the Republic of Korea developed "smart" electronic glasses that can monitor the wearer's brain waves and body movements—in addition to functioning as sunglasses and controlling video games by detecting eye motions. The 3D-printed eyeglass frame was tricked out with flexible electrodes; a wireless circuit for motion and UV sensing; and UV-responsive, color-adjustable lenses. The team says its creation could be useful in digital-healthcare and virtual-reality applications.

Making the invisible visible: As with other many areas, metasurfaces are entering the field of optometry. An international team of researchers developed a metasurface, using nanoscale crystals, that could one day be directly applied to glasses and enable night vision for the wearer. These and other technologies should continue to broaden spectacles' functionalities—pushing eyeglasses ever closer to the futuristic depictions from science fiction.

For references and further resources, go online: optica-opn.org/then-now/eyeglasses.

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