

Metalenses at visible wavelengths: past, present, perspectives
Authors: Philippe Lalanne, Pierre Chavel
Institut d'Optique, CNRS

Since the publication of a research article in *Science* that revisited Snell's law at the interface between two uniform media thanks to an ultrathin metallic grating etched on the interface [*Science* 334, 333 (2011)], metasurfaces and especially metalenses, are the subject of an intense research activity, leading to numerous publications in high-impact journals and great promises. A recent research article [*Science* 352, 1190 (2016)] that reports metalenses manufactured with a high numerical aperture (NA) operating at visible wavelengths is particularly emblematic of this growing interest. Comparisons with a state-of-the-art commercial objective suggest that the image quality is as good and even better, and considering their flat nature and compact size, metalenses appear as potentially revolutionary. However, metalenses do not come out of the blue and the so-called 'flat optics' that shapes the phase of free-space waves through subwavelength structures have a venerable history over many years from the microwave domain down to the visible. What is the paradigm change at the source of this anticipated revolution? New fabrication processes, new concepts, new applications, fundamental limitation shifts?

To answer these questions, we confront recent metalens achievements with an historical perspective of flat optical elements, to further analyze the fundamental limitations that have been lifted and better anticipate perspectives offered by flat optics. This is precisely the outline of the present article, which starts with a brief overview of the fundamentals of flat optics.