New antireflective coating reduces stray light and reflections

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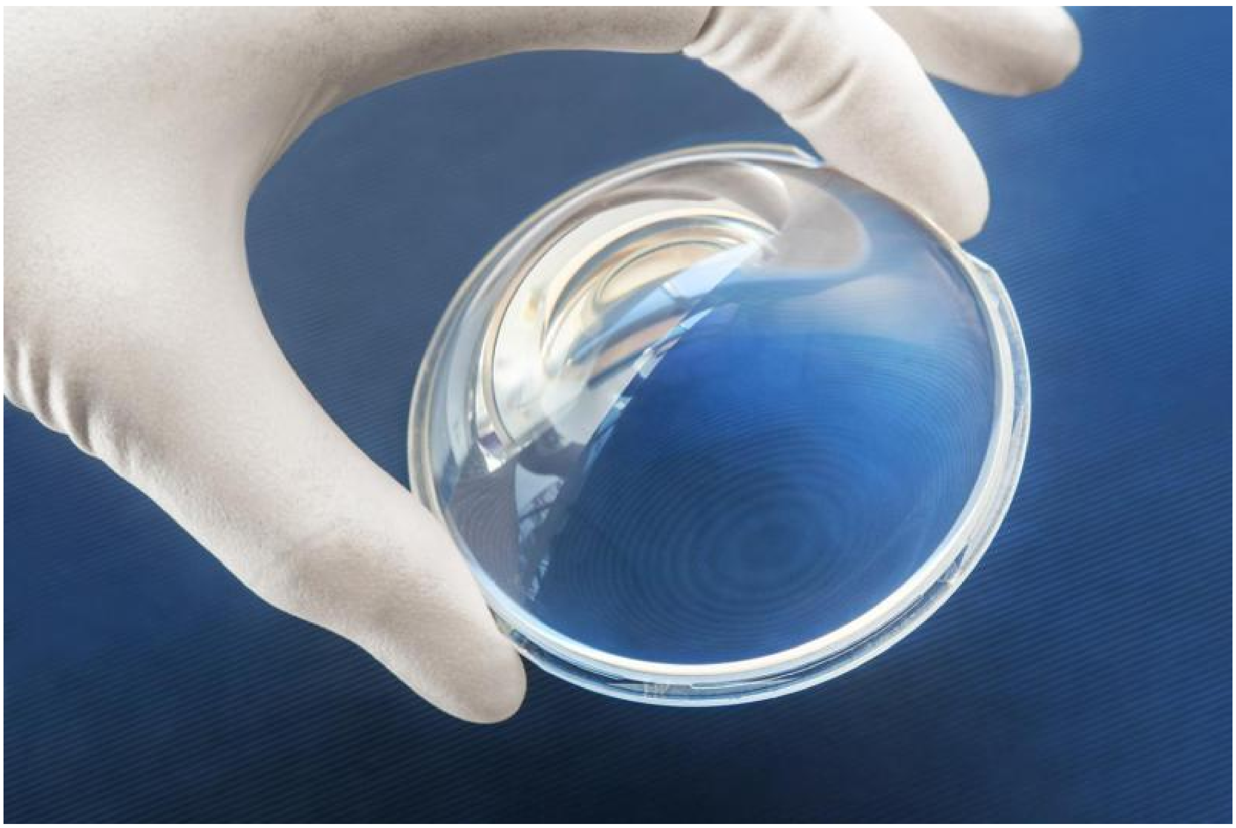

Injection-molded optical lens made from transparent plastic demonstrating the nanostructured antireflective coating. Only the coated right half shows the effect of the antireflection system. The uncoated left half reflects the light. Credit: Fraunhofer IOF

Transparent plastic optical lenses can be manufactured cheaply and in any shape. However, a downside is that they reflect light just as much as glass does. At the K trade fair in Düsseldorf, Fraunhofer researchers are exhibiting a new type of antireflective coating that significantly reduces stray light and reflections from plastic lenses. Not only does this improve the performance of cameras and headlights, it's also good news for virtual reality technologies and Industrie 4.0.

Optical lenses' main task is to focus light. They enable cameras to take sharply focused photos, and LED headlamps to shine brightly and flexibly adjust their beam. For optimum control over the path of a ray of light, complex lens systems are necessary. These consist of several differently shaped lenses. Today, the preferred material for lenses is transparent plastic, as the inexpensive process of plastic injection molding can be used to produce lenses in any shape. However, one problem remains: the fact that light reflects from the lenses' surface. Plastic has a refractive index (a measure of how much light is reflected) of approximately 1.5. In contrast, the refractive index of air is 1; this means plastic lenses reflect roughly 8 percent of incoming light. "Curved surfaces intensify this effect when light strikes them at an oblique angle of incidence," explains Dr. Ulrike Schulz from the Plastic Optics department at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena.

Refractive index greatly reduced

Fraunhofer IOF scientists will be attending the K 2016 trade fair in Düsseldorf, the most important trade fair for the plastics and rubber industry worldwide, from October 19-26 (Hall 7, Booth SC01) to exhibit a new type of antireflective coating for curved plastic lenses. The coating reduces the refractive index at the surface of plastic optics almost to 1.1, offering a near-perfect transition to air. Fraunhofer IOF has recently tested prototypes of the coating in different lens systems, in close cooperation with industry partners. The results show that the technique noticeably reduces what is known as stray light: reflected light that scatters through the lens systems, for example in cameras, and interferes with how they focus rays of light. Moreover, the researchers' experiments proved that lenses treated with the antireflective coating developed at Fraunhofer IOF let through significantly more light than conventional lenses. This new technology will be of benefit not only in camera optics and car headlamps but also to several growth areas such as virtual reality or gesture controlled devices for Industrie 4.0. "Imaging systems are growing ever more important as a data gathering tool – and they will need ever more powerful optical lenses," Dr. Schulz predicts.

New multilayer nanomaterial

The antireflection system developed by the Fraunhofer IOF researchers in Jena sandwiches several innovative nanostructured film layers with conventional homogeneous oxide layers. In successive layers, the researchers dilute the plastic with more air, until the refractive index at the surface is almost equal to that of air. They accomplish this using new nanomaterials that can be applied to lenses with complex shapes. The stacking of multiple layers allows them to double the thickness of the antireflective coating relative to previous solutions. Conventional antireflective coatings can only be distributed unevenly on curved lenses – such that the coating is always thinner at the edge than on the convex center. "This physical thinness translates into optical thinness: the thinner layer only prevents reflections of short-wave light. By contrast, several layers of nanostructured film can cover a wider wavelength spectrum, while at the same time reducing reflections of light at oblique angles," Dr. Schulz explains. Plastic optics are particularly suited to this process. The bottom layer of the antireflective coating can be directly incorporated into the plastic using plasma etching. "In this way, we can apply antireflective coating to a wide range of plastics," Dr. Schulz says.

Provided by Fraunhofer-Gesellschaft

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