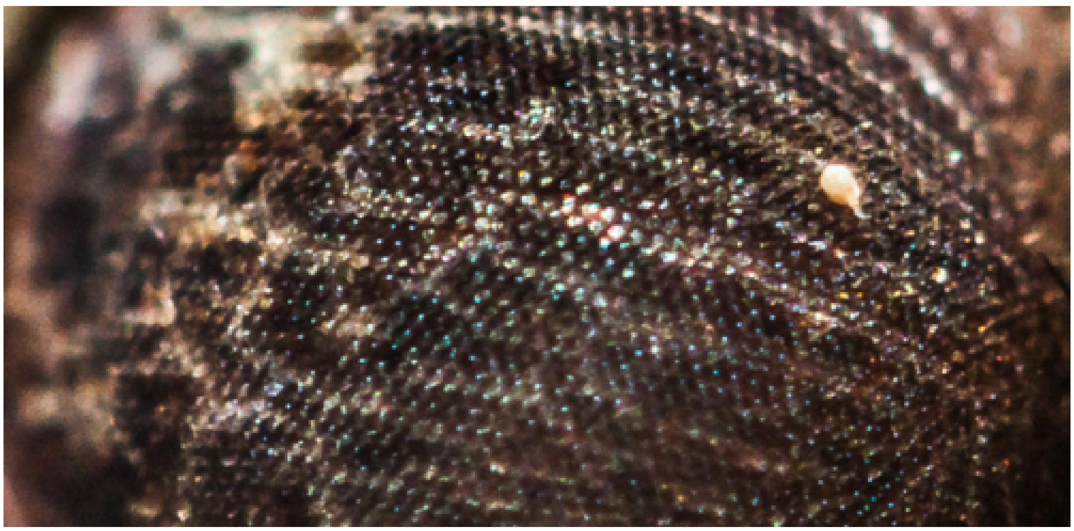
Self-cleaning, antireflective coating mimicks the structure of moth eyes

February 21 2014



(Phys.org) —Porous films, which use similar properties to those seen in moth eyes in combination with nanoparticles, are being developed into robust, self-cleaning antireflective coatings for use on both plastic and glass.

Details of the coatings, which were developed by researchers at the University of Cambridge, were recently outlined in the journal *Nano Letters*.

Antireflective coatings need to refract as little light as possible in order to be effective, but it is extremely difficult to produce them as a single layer. Over the past decade, researchers have developed distributed coatings, which resolve this by mimicking the structure of moth eyes.

The antireflective properties of moth eyes come not from a single layer, but from a hexagonal pattern of tiny bumps. The spaces between these bumps are so small that incoming beams of light see the eye's surface as a single layer, essentially removing the interface between the air and the surface, allowing moths to see at night and be less visible to predators.

The problem with synthetic versions of moth eye coatings is that the tiny spaces which make the coating antireflective in the first place can very quickly become clogged with dirt, which cause the antireflective effect to be lost.

Professor Ulli Steiner and colleagues from the Cavendish Laboratory have developed a new coating which is both antireflective and self-cleaning. In order to develop it, Professor Steiner and his co-inventors came up with a strategy to make layers of plastic with very well-defined small pores, similar to moth eyes. But by making the pores larger than they are in most other types of moth eye coatings, they were able to incorporate titanium dioxide nanocrystals into the structure.

These nanocrystals are photocatalytic—when light falls on them, they start to break down the dirt clogging the pores, until all that is left is carbon dioxide, and water which evaporates off the surface, rendering the material self-cleaning.

In early tests of the material, the titanium dioxide nanoparticles were able to break down all of the oils contained in a fingerprint within 90 minutes. The coating is capable of breaking down most of the standard hydrocarbons that clog most porous antireflective coatings.

The breakthrough research is the first time that these nanoparticles have been effectively incorporated into antireflective coatings, raising the possibility of antireflective, self-cleaning glass or plastic.

The coating adheres to the substrate through sol-gel chemistry, resulting in a durable bond and a coating which will not flake off.

While the material is currently only suitable for outdoor applications as it requires ultraviolet light for photocatalysis to occur, the team are planning more tests to see if the material could be adapted in future for indoor light, which would open up a wide range of potential applications.

The team are currently looking at applications in building glass and solar cells, as much of the sunlight solar cells are meant to capture and convert to energy simply bounces off the surface, and current antireflective coatings become easily clogged with dirt. "When generating energy from solar cells, you have to fight for every percentage gain in efficiency," said Professor Steiner. "The coating we've developed combines two interesting scientific principles, and could increase the amount of light getting into the solar cells."

More information: "Self-Cleaning Antireflective Optical Coatings." Stefan Guldin, Peter Kohn, Morgan Stefik, Juho Song, Giorgio Divitini, Fanny Ecarla, Caterina Ducati, Ulrich Wiesner, and Ullrich Steiner. *Nano Letters* 2013 13 (11), 5329-5335 DOI: 10.1021/nl402832u

Provided by University of Cambridge