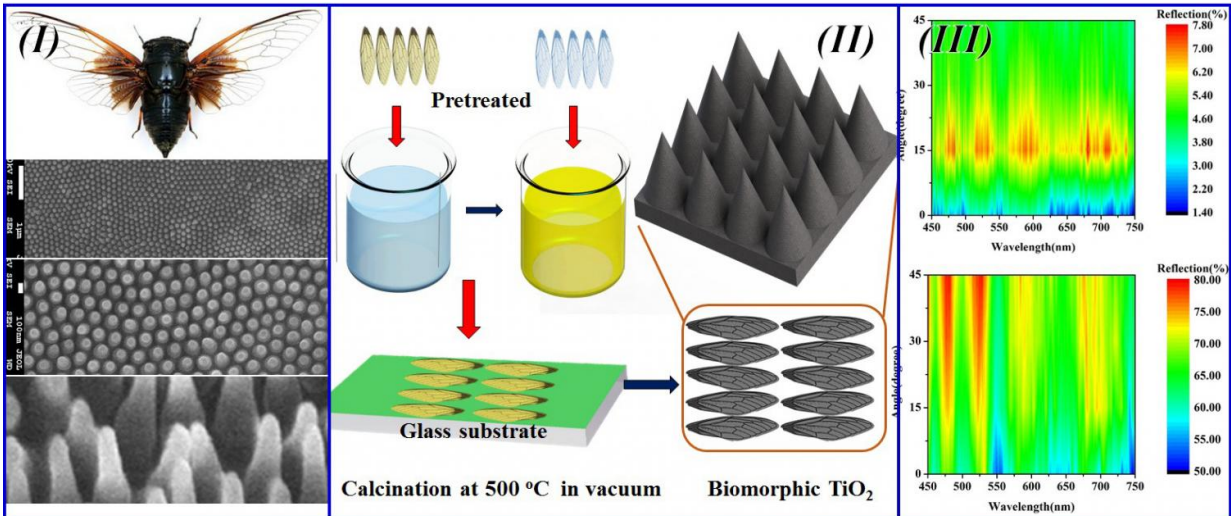


Cicada wings inspire antireflective surfaces

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I. Photograph and scanning electron microscope characterizations of a black cicada wing (*Cryptympana atrata* Fabricius). II. Synthesis process of biomimetic TiO₂ with ordered nano-nipple array structures. III. Counter map angle-dependent antireflection of biomimetic TiO₂ and non-templated TiO₂, respectively. Credit: Shanghai Jiao Tong University

A team of Shanghai Jiao Tong University researchers has used the shape of cicada wings as a template to create antireflective structures fabricated with one of the most intriguing semiconductor materials, titanium dioxide (TiO₂). The antireflective structures they produced are capable of suppressing visible light—450 to 750 nanometers—at different angles of incidence.

Why cicada wings? The surfaces of the insect's wings are composed of highly ordered, tiny vertical "nano-nipple" arrays, according to the researchers. As they report this week in *Applied Physics Letters*, the resulting biomorphic TiO₂ surface they created with antireflective structures shows a significant decrease in reflectivity.

"This can be attributed to an optimally graded [refractive index](#) profile between air and the TiO₂ via antireflective structures on the surface," explained Wang Zhang, associate professor at State Key Laboratory of Metal Matrix Composites, Shanghai Jiao Tong University in China.

Small spaces between the ordered nano-antireflective structures "can be thought of as a light-transfer path that let incident light rays into the interior surface of the biomorphic TiO₂—allowing the incident light rays to completely enter the structure," Zhang continued. "The multiple reflective and scattering effects of the antireflective structures prevented the incident light from returning to the outside atmosphere."

Significantly, the team's work relies on "a simple and low-cost sol-gel (wet chemical) method to fabricate biomorphic TiO₂ with precise subwavelength antireflective surfaces," Zhang pointed out. "The TiO₂ was a purely anatase phase (a mineral form of TiO₂), which has unique antireflective surfaces. This led to an optimally graded refractive index and, ultimately, to angle-dependent antireflective properties within the visible light range."

In terms of applications, the team's biomorphic TiO₂ antireflective structures "show great potential for photovoltaic devices such as solar cells," Zhang said. "We expect our work to inspire and motivate engineers to develop antireflective surfaces with unique structures for various practical applications."

Even after high calcination at 500 C, the antireflective structures retain

their morphology and high-performance antireflection properties. These qualities should enable the coatings to withstand harsh environments and make them suitable for long-term applications.

In the future, the team plans "to reduce the optical losses in solar cells by using materials with a higher refractive index such as tantalum pentoxide or any other semiconductor materials," Zhang said.

More information: "Angle-dependent antireflection property of TiO₂ inspired by cicada wings," by Imran Zada, Wang Zhang, Yao Li, Peng Sun, Nianjin Cai, Jiajun Gu, Qinglei Liu, Huilan Su and Di Zhang, *Applied Physics Letters* on October 11, 2016 . [DOI: 10.1063/1.4962903](https://doi.org/10.1063/1.4962903)

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