Towards the development of biomimetic optical devices

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The implementation of concepts from nature in different technoscientific fields is called biomimetics. The new feature of biomimetics is the ability to design and produce micro- and nano-scaled features and devices. Motivated by the idea of biomimetic optical devices, the conformal evaporated-film-by-rotation (CEFR) technique was devised to fabricate inorganic replicas of biotemplates with high reliability and fidelity at the micro- and nano-scales. The CEFR technique is particularly well suited for bioreplication as the temperatures involved during deposition are sufficiently low and the replication process occurs in a non-corrosive environment, thereby avoiding damage to the underlying biotemplate.

The compound eyes of insects are attractive candidates for bioreplication as they present a desirable optical scheme for imaging with a very wide field of view. In this regard, using the CEFR technique, we have successfully created replicas of the eyes of flies, finding that there is neither a distortion of the original structure nor any observable new structure created by the replication technique. We have experimentally determined that a similar optical response in the visible and near-infrared frequency regimes is observed before and after replication, thereby indicating that the structure of the biotemplate was replicated with high fidelity, preserving the original optical functionality. Replicate devices could serve to enhance light collection for solar energy collectors, optical communication systems or microcameras.

We have also used the CEFR technique to replicate wings of butterflies. The butterfly wing has a photonic band-gap structure that provides its particular color as well as additional functionalities, including aerodynamics, light weight, mimicry, and camouflage. The wing is composed of thousands of scales. These are intricately shaped with stratification, voids, and grooves of complex shapes that result in several optical effects, such as interference, scattering, and diffraction. Since the morphology of the butterfly wing makes it a very efficient diffuser of light, the replica could be used as an antireflection structure for increased photon trapping or as an optical diffuser.

References:

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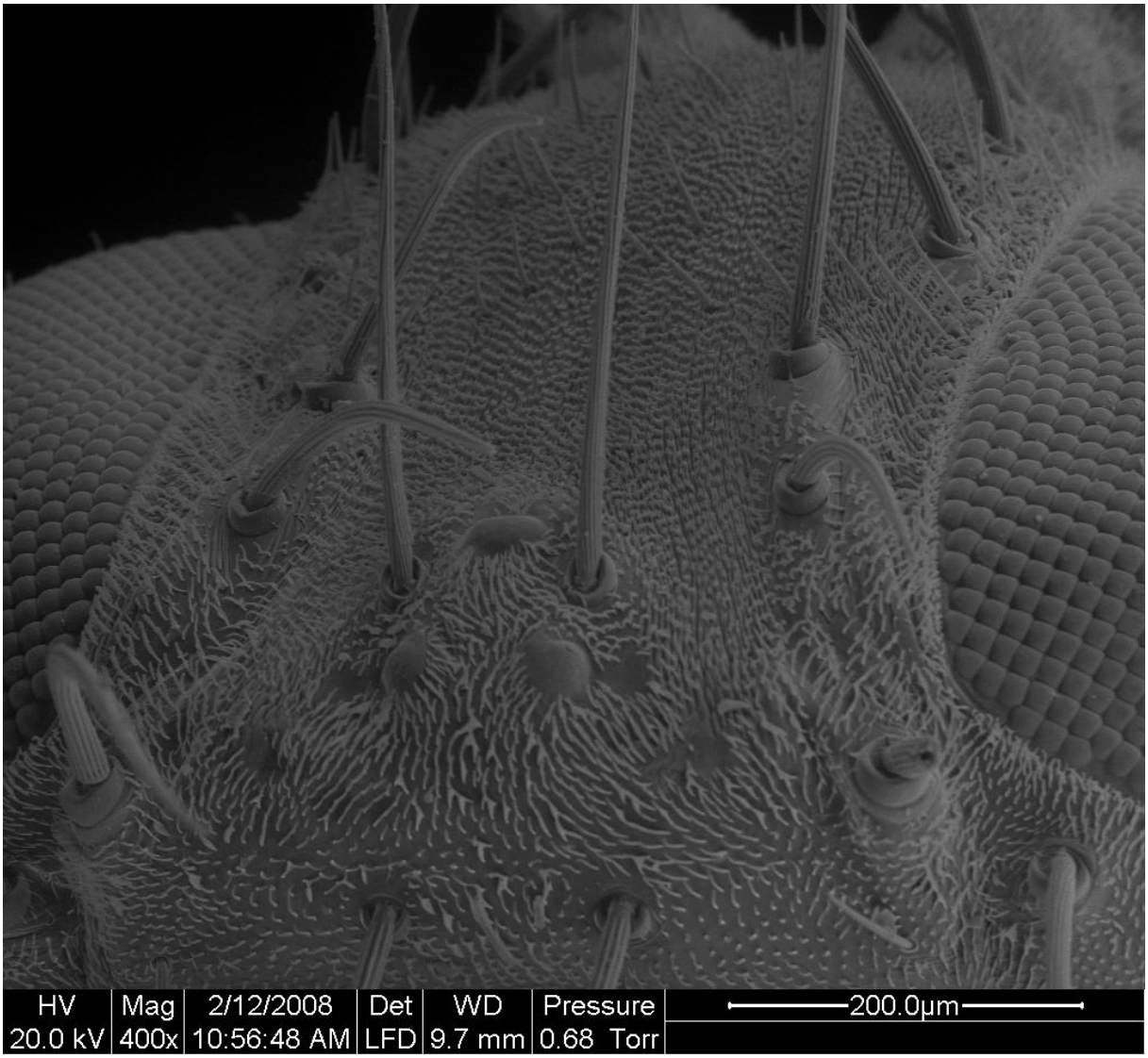
Figures: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