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Institute of Microstructure Technology
Biomimetic Surfaces and Scanning Probe Technologies

How Nanopores and Microcavities Control the Light Reflectance Properties of Snake Ventral Scales

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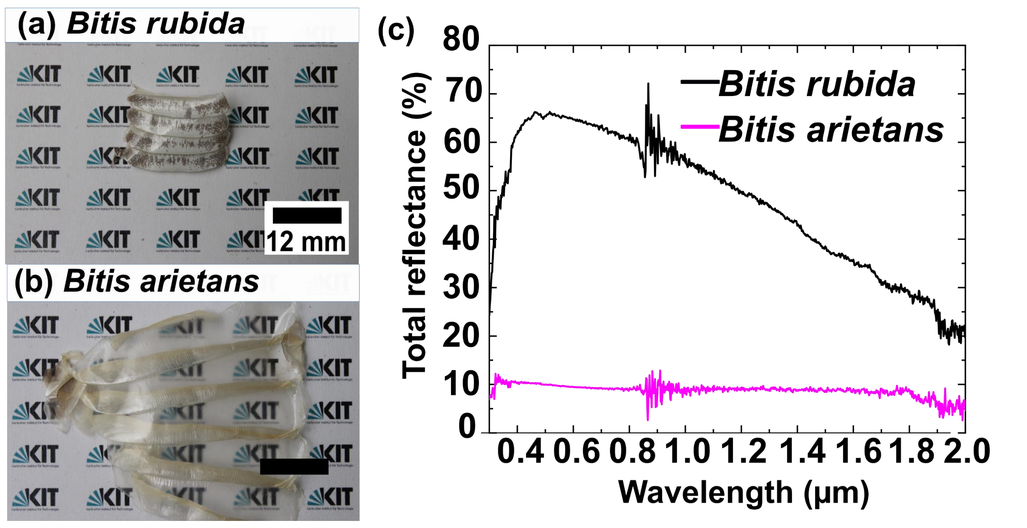
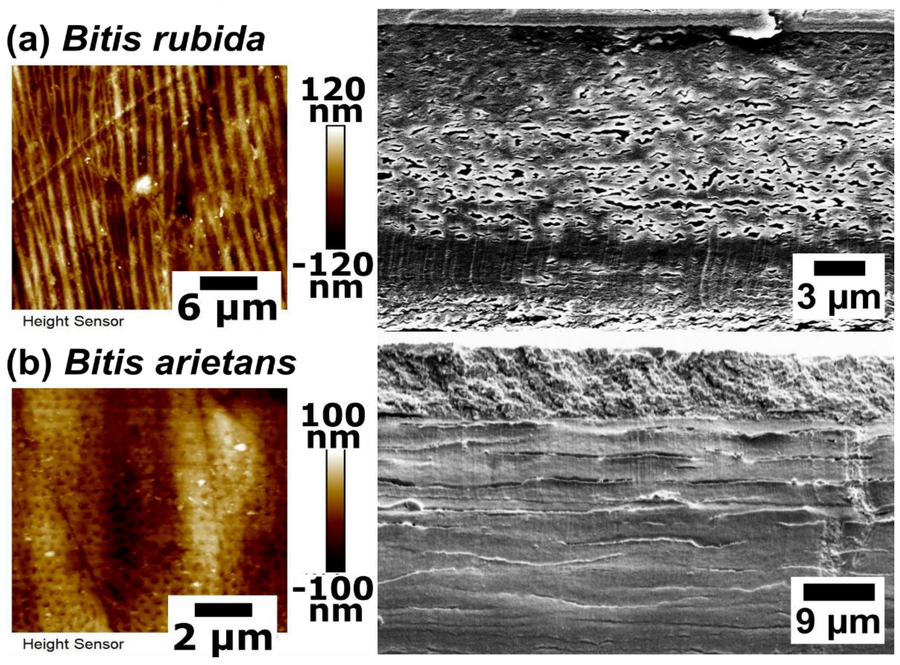
All natural organisms have adapted themselves for survival over millions of years of evolution. For example, alongside locomotion snakes living in equatorial, hot and humid climates developed white reflecting ventral scales to avoid overheating caused by highly radiative soil and rocks [1-9]. Interestingly, some snakes also developed silvery-white ventral scales which promote anisotropic reflection. This study explains the mechanism through which snakes achieve such thermoregulatory and optical properties.



Photographs of (a) white reflecting scales of *B. rubida;* and (b) transparent/translucent scales of *B. arietans.* (c) Reflectance of the white reflecting and transparent ventral scales.

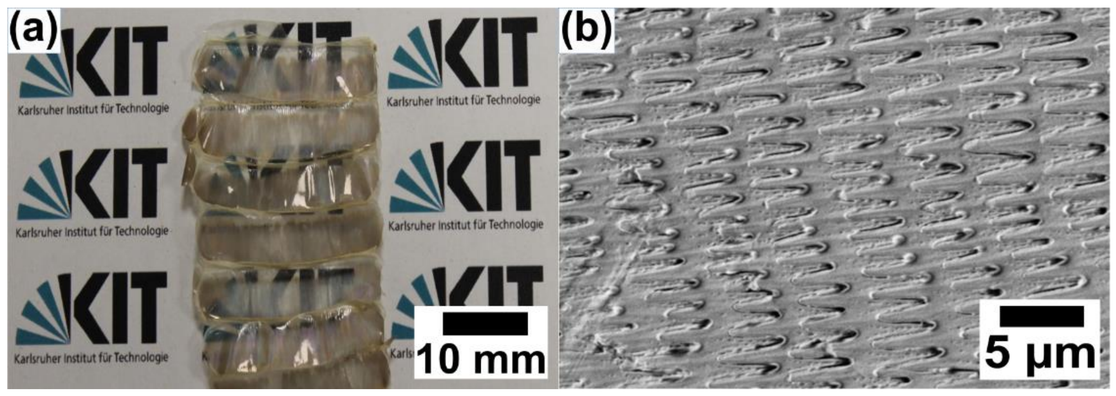
Photographs of snake scales placed on top of a print of university logo indicate difference in their physical appearance. In difference to the transparent/translucent scales higher reflectance is observed for the reflecting white scales in UV and NIR light (thermoregulation).



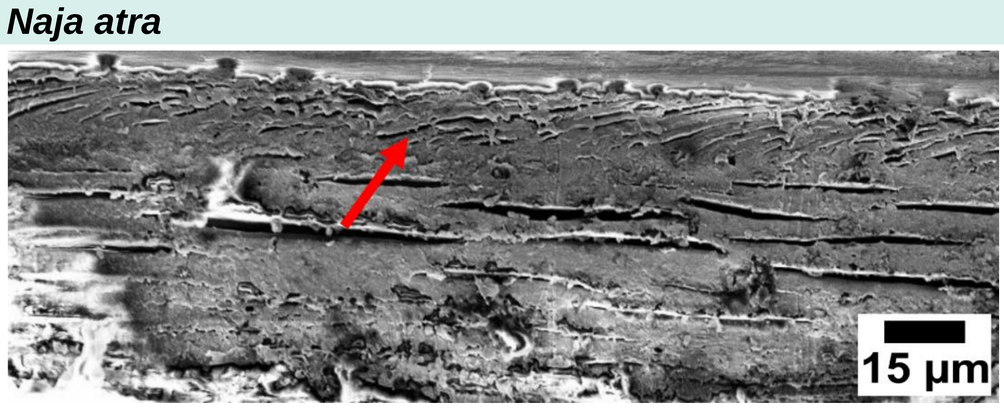
AFM images of surface topography and cross-section SEM micrographs of the ventral scales of (a) *Bits rubida and* (b) *Bitis arietans.*

AFM images indicate shallow nanoridges and nanopits on the ventral scales of *B. rubida* and *B. arietans.* Cross-section SEM micrographs reveal numerous nanopores embedded within the reflecting white scales. However, an amorphous structure without pores is found in the transparent/translucent scales.

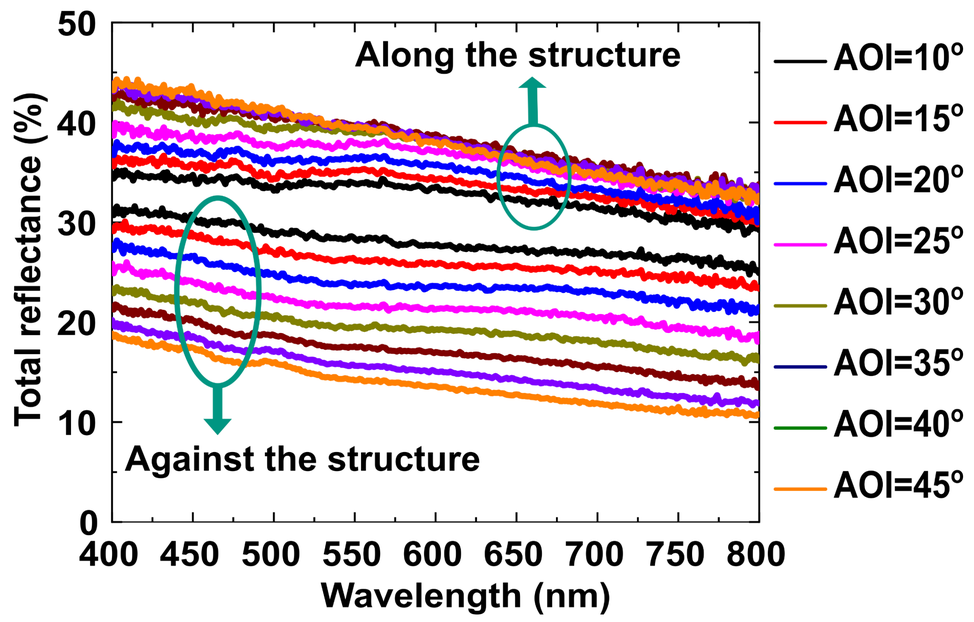
The photograph below shows the silvery-white ventral scales of *Naja atra*. SEM micrograph presents the shallow micro-structures on the scales.



(a) Photograph and (b) SEM micrographs of the ventral scales of *Naja atra*



SEM micrographs of a scale cross-section reveal alternating layers of tilted micro-cavities within the scales (see arrow)



Reflectance of the ventral scales of *Naja atra*

Anisotropic reflection is observed on the scales when measured along and against the micro-structures. These tilted microcavities might result to such optical phenomenon.

Light interacts with optimized nanopores and tilted microcavities to develop white and silvery-white anisotropic reflecting snake scales. Comparison with their transparent/translucent scales further verifies these mechanisms.

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