

**Title:****Butterfly Wing Scales as Inspiration for Advanced Building Materials****Authors:**

F. Zischka<sup>1</sup>, V. Kaser<sup>2</sup>, K. Whitmore<sup>3</sup>, R. Kainradl<sup>4</sup>, H. W. Krenn<sup>5</sup>, S. Gaal-Haszler<sup>6</sup> and I. C. Gebeshuber<sup>1</sup>

[florian.zischka@tuwien.ac.at](mailto:florian.zischka@tuwien.ac.at)

[viola.kaser@student.tugraz.at](mailto:viola.kaser@student.tugraz.at)

[karin.whitmore@tuwien.ac.at](mailto:karin.whitmore@tuwien.ac.at)

[r.kainradl@zoovienna.at](mailto:r.kainradl@zoovienna.at)

[harald.krenn@univie.ac.at](mailto:harald.krenn@univie.ac.at)

[sabine.gaal@nhm-wien.ac.at](mailto:sabine.gaal@nhm-wien.ac.at)

[gebeshuber@iap.tuwien.ac.at](mailto:gebeshuber@iap.tuwien.ac.at)

<sup>1</sup>Institute of Applied Physics, TU Wien, Vienna, Austria

<sup>2</sup>TU Graz, Austria

<sup>3</sup>University Service Center for Transmission Electron Microscopy, TU Wien, Vienna, Austria

<sup>4</sup>Schönbrunn Zoo, Vienna, Austria

<sup>5</sup>Department of Evolutionary Biology, Unit Integrative Zoology, University of Vienna, Austria

<sup>6</sup>Lepidoptera Collection, Natural History Museum, Vienna, Austria

**Abstract:**

Global warming advances and urban areas are plagued by increasingly severe heat waves each summer, underlining the urgent need for innovative cooling solutions in cities.

Butterflies wing scales, with their multifunctional nanostructures, can inspire us in this matter. The structures provide properties ranging from structural coloring, hydrophobicity and self-cleaning properties to structural integrity and passive thermoregulation. Recent research on scent scales - special scales, used by butterflies to distribute pheromones - indicates that they exhibit interesting thermal properties, especially within the atmospheric window (the wavelength spectrum from 7.5  $\mu\text{m}$  - 13  $\mu\text{m}$ , where ~~our~~ atmosphere is transparent for radiation ~~within that range~~).

This research ~~aims to explore~~ various types of butterfly scales at micrometer and nanometer ~~scales~~ for potential applications in building thermoregulation.

With Scanning electron microscopy (SEM) and Focused ion beam (FIB) techniques it is managed to cut into single scales, to analyze the cross-section of these structures and to provide first expert guesses about structure-function relationships. Color scales, scent scales and reflective scales from various butterfly species (both tropical and native to the temperate zone of Middle Europe) are compared, to determine, ~~whether~~ specific nanostructures could be responsible for thermal features such as passive radiative cooling. This investigation seeks to pave the way for new, sustainable materials in the field of materials engineering.