

Comparative Study of Cicada Wing Nanoscale Surfaces for Species-Linked Molecular Organization Studies

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Purpose:

- Demonstrate how changes in chemical and structural profiles of cicada wing surfaces influence their functionality.
- Untargeted search for correlation of these profiles to the investigated functionalities.

Methods:

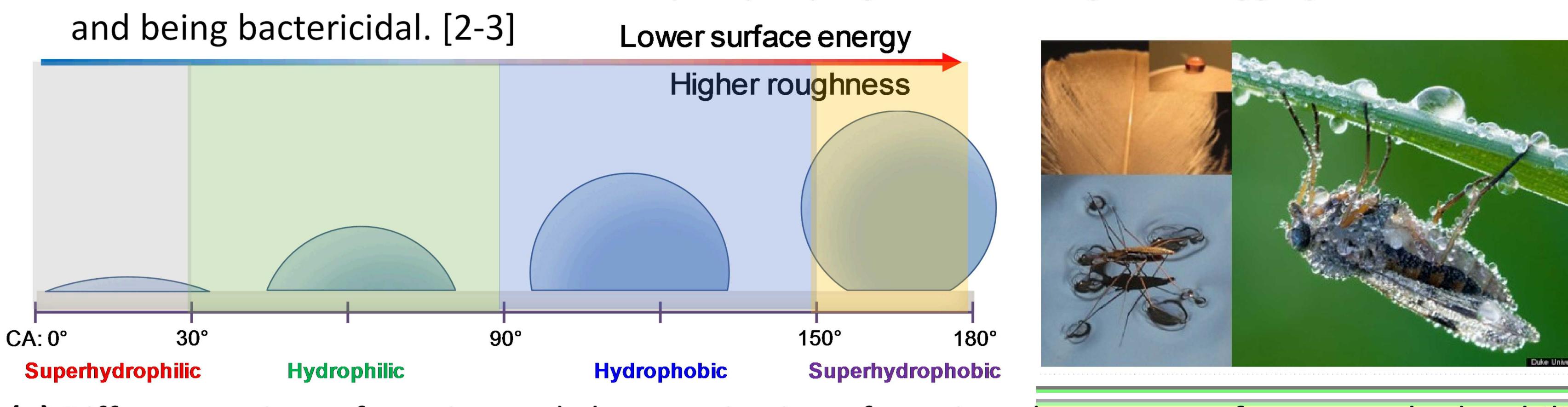
- Investigate wing functionalities (hydrophobicity, biofouling, antimicrobial).
- Utilize GC-MS to detect compounds extracted from wing surfaces.
- Develop in-situ method for spatially-resolved analysis of cicada wings.

Results:

- Hydrophobic components were observed in chemical extract of cicada wing surfaces.
- Functionality directly correlates to structural and chemical changes on the wing surface.
- Designed a novel method for the analysis of desiccated materials with LAESI. [1]

Introduction

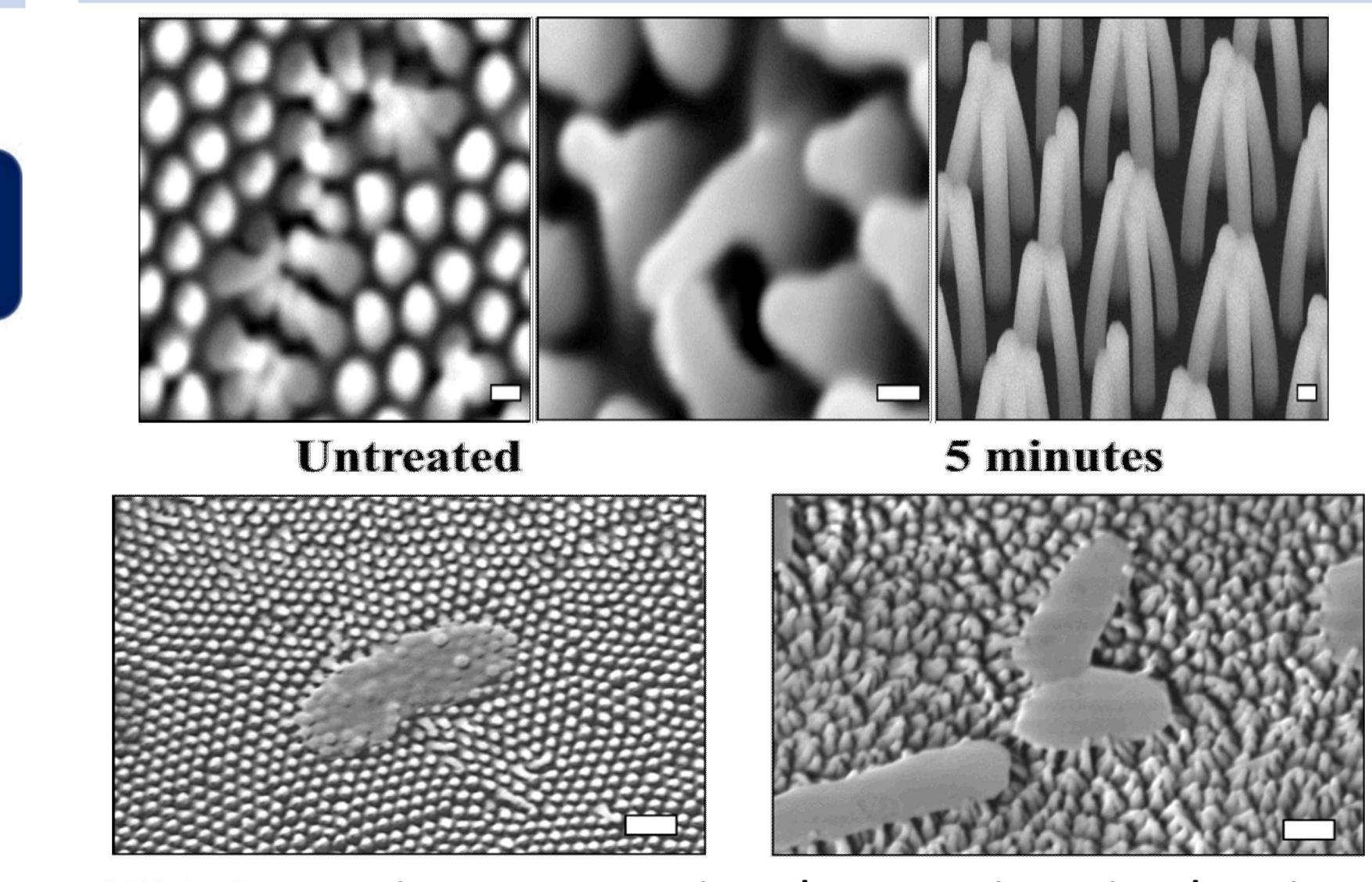
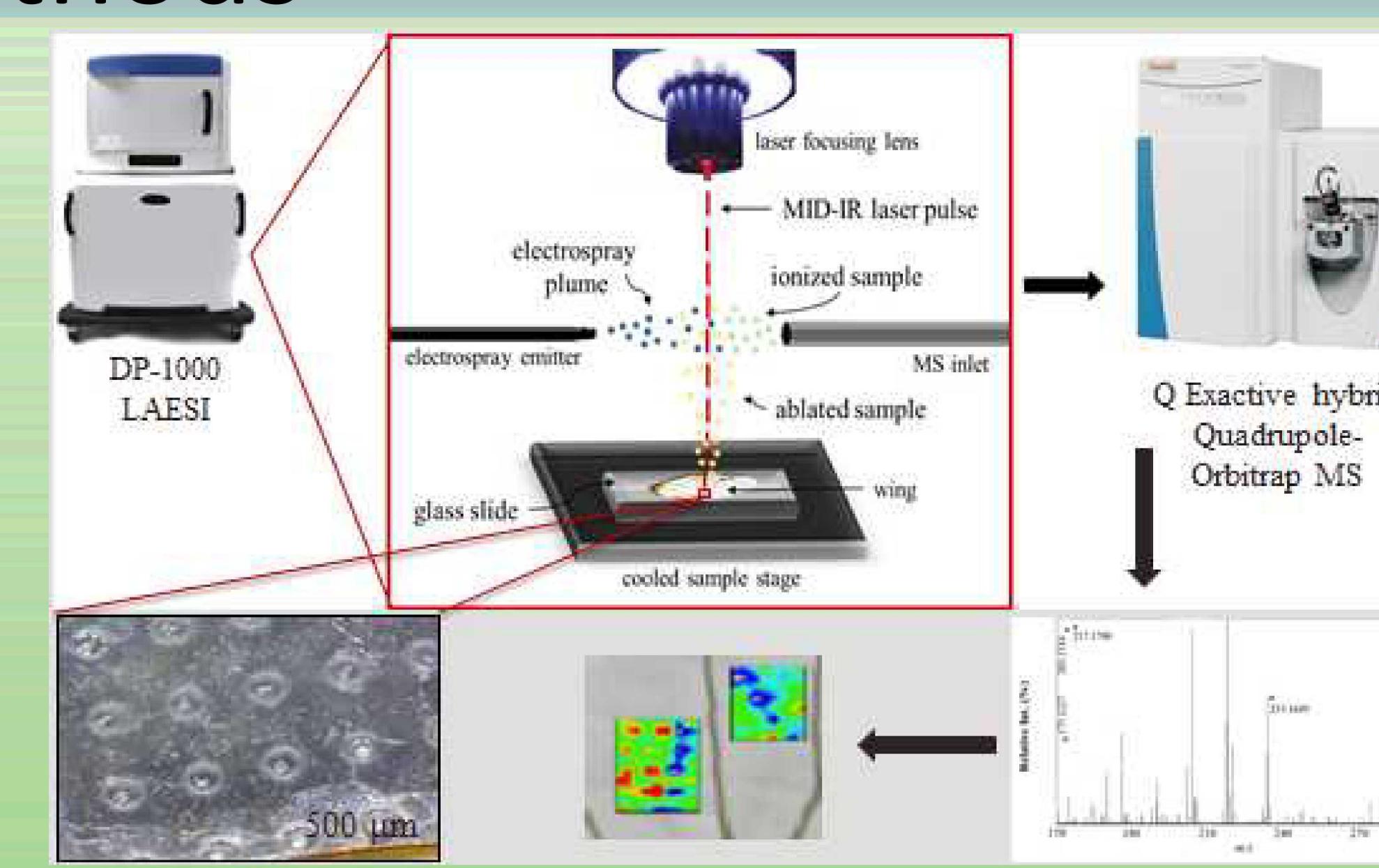
- Understanding what physical and chemical elements give biological materials favorable characteristics will help in the design of engineered materials with similar characteristics which can be used in various applications.
- Insect wings have been shown to possess nanostructures that affect wettability which in turn results in functionalities such as droplet jumping, self-cleaning, anti-fogging, anti-reflectivity and being bactericidal. [2-3]



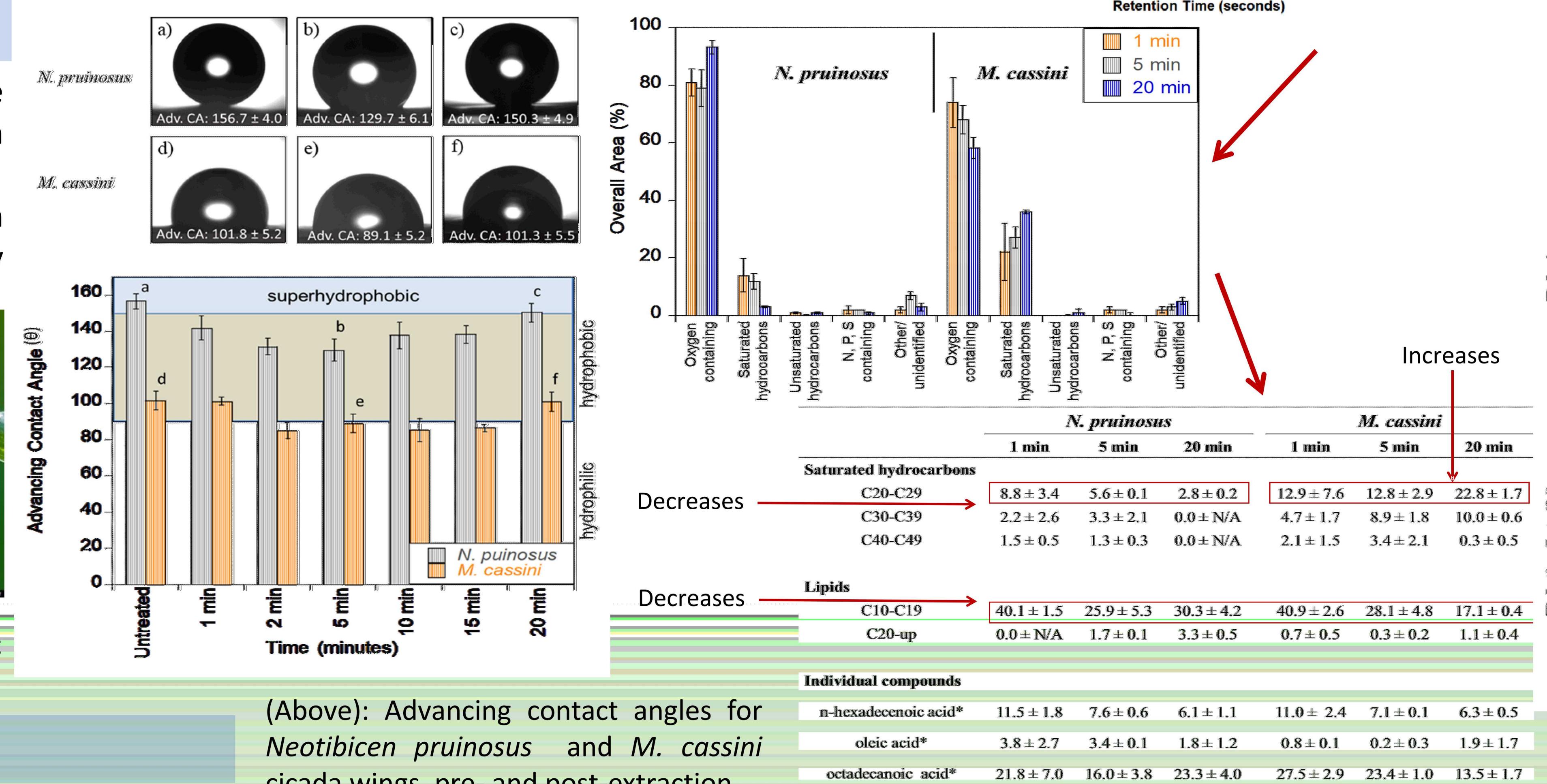
(a) Different regime of wetting and characterization of wetting phenomena, from superhydrophilic (CA<30°) to superhydrophobic (CA>150°), (b) various wetting phenomena observed in nature.

Methods

- Microwave-assisted extraction of wing (*N. pruinosus* and *M. cassini*) surface components.
- Identify the composition of the extracted material via GC-MS.
- Track wing functionality over various extraction degrees.
- Determine optimal analysis conditions for wing analysis on laser-ablation electrospray ionization (LAESI), for which there was no previous method for the analysis of desiccated materials. [1]
- Correlate chemical and physical analysis to the functionality of wing surfaces.



SEM: Post microwave-assisted extraction cicada wing (top-left/middle), artificial structures (top-right), attached bacteria to cicada wing surface (bottom).

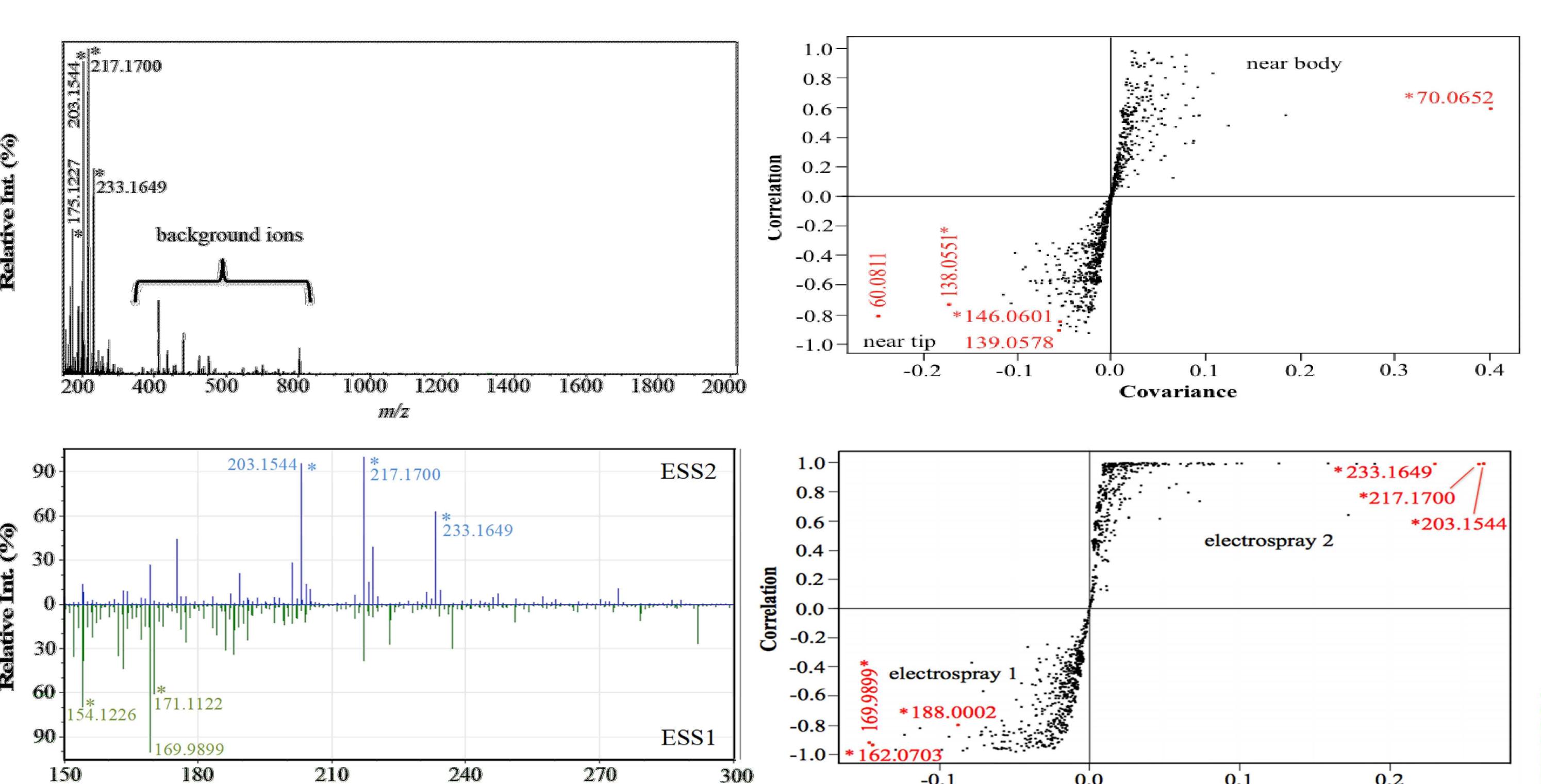
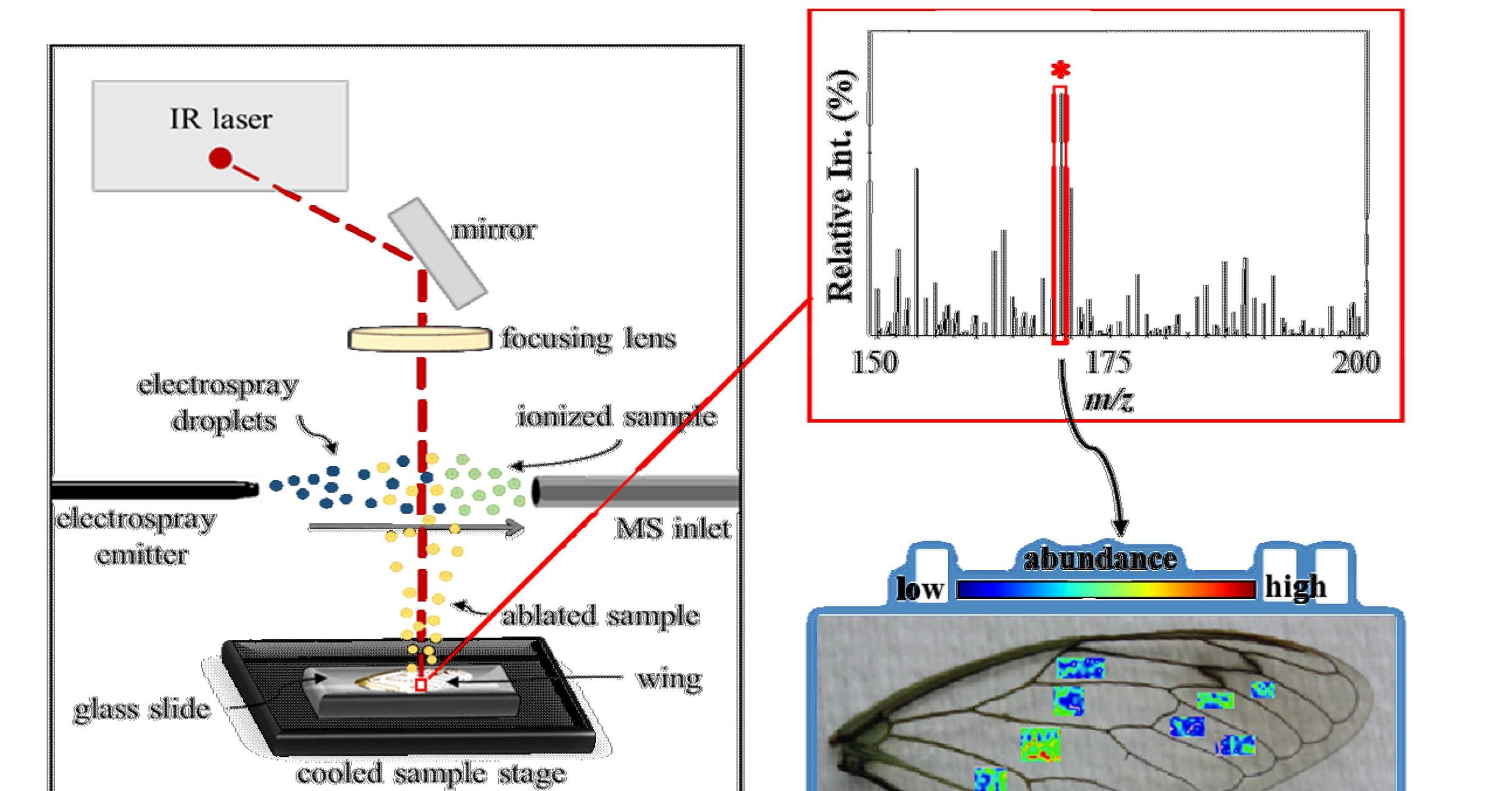


(Above): Advancing contact angles for *Neotibicen pruinosus* and *M. cassini* cicada wings, pre- and post-extraction.

n-hexadecenoic acid*	11.5 ± 1.8	7.6 ± 0.6	6.1 ± 1.1	11.0 ± 2.4	7.1 ± 0.1	6.3 ± 0.5
oleic acid*	3.8 ± 2.7	3.4 ± 0.1	1.8 ± 1.2	0.8 ± 0.1	0.2 ± 0.3	1.9 ± 1.7
octadecanoic acid*	21.8 ± 7.0	16.0 ± 3.8	23.3 ± 4.0	27.5 ± 2.9	23.4 ± 1.0	13.5 ± 1.7

Results

Laser-ablation electrospray ionization methodology.

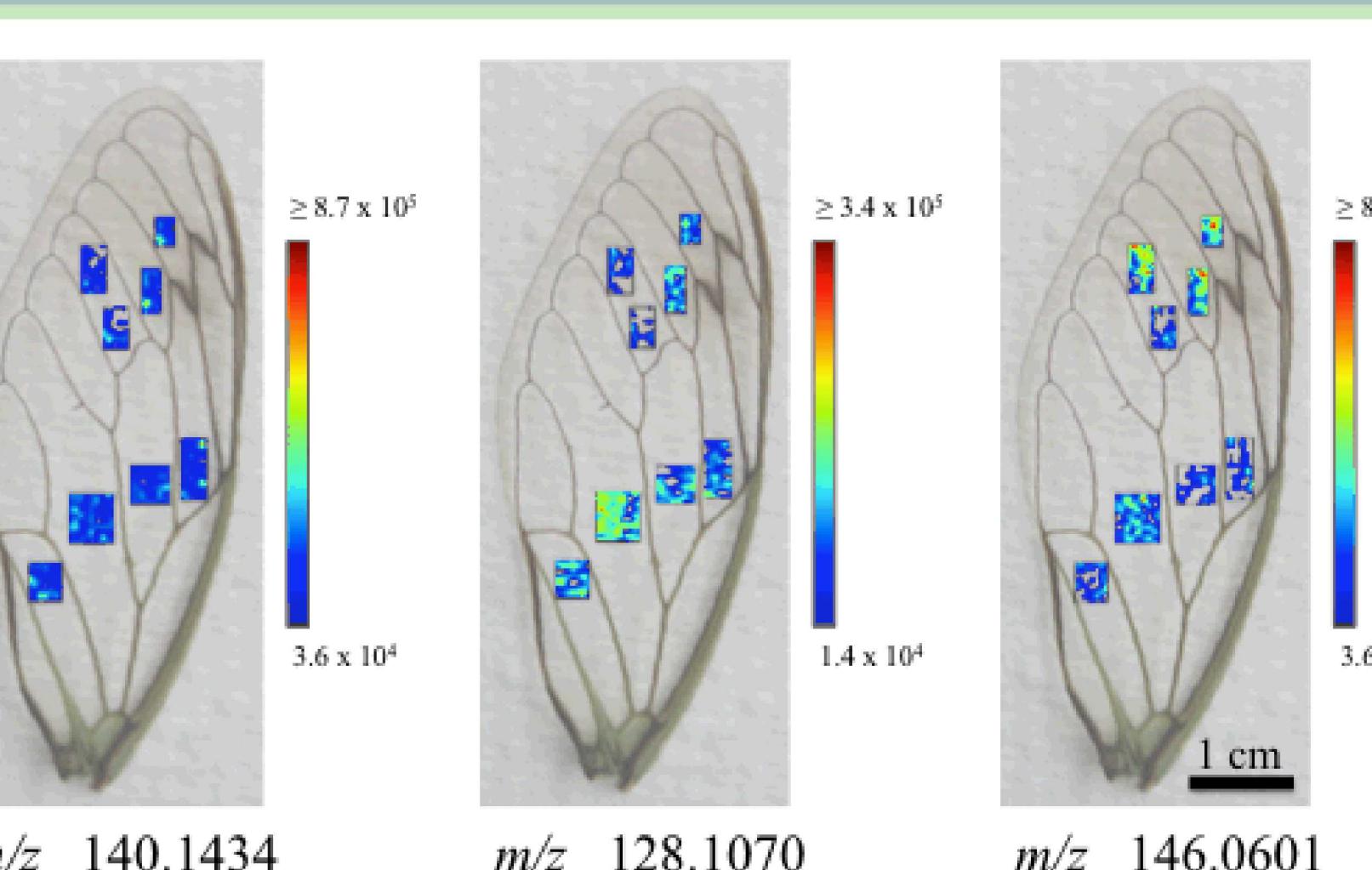


ESS1: methanol-water-formic acid (50:50:0.1)
ESS2: methanol-acetonitrile-toluene-formic acid (50:35:15:0.1)

Conclusions

This study investigated the influence of surface chemistry, in combination with wing topography, on the functionalities of the wing, including wettability and antimicrobial properties. By being able to predict and study wing topography, wettability, the development of rational design tools for the manufacture of artificial surfaces for energy and water applications can be expedited.

Developing a method for the LAESI analysis of fragile samples expands the range of testable sample materials, whether biological or man-made.



References

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