

2016

2016 MRS Spring Meeting

March 28–April 1, 2016
Phoenix, AZ
www.mrs.org/spring2016

EPMA 2016: Electron Probe Microanalysis Topical Conference

May 16–19, 2016
Madison, WI
www.microbeamanalysis.org/topicalconferences/epma-2016-1/epma-2016

APMC11 – 11th Asia-Pacific Microscopy Conference

May 23–27, 2016
Phuket, Thailand
www.apmc11.org

EBS D 2016 Electron Backscatter Diffraction Topical Conference

May 24–26, 2016
Tuscaloosa, AL
www.microbeamanalysis.org/topical-conferences/ebsd-2016/welcome

Inter/Micro: 68th Annual Applied Microscopy Conference

June 6–10, 2016
Chicago, IL
www.mcri.org

43rd MSC Annual Meeting

June 7–10, 2016
Edmonton, Alberta
<http://conference2016.msc-smc.org>

Microscopy & Microanalysis 2016

July 24–28, 2016
Columbus, OH
www.microscopy.org

European Microscopy Congress

August 28–September 2, 2016
Lyon, France
<http://emc2016.fr>

2017

Microscopy & Microanalysis 2017

July 23–27, 2017
St. Louis, MO
www.microscopy.org

2018

Microscopy & Microanalysis 2018

August 5–9, 2018
Baltimore, MD
www.microscopy.org

2019

Microscopy & Microanalysis 2019

August 4–8, 2019
Portland, OR
www.microscopy.org

2020

Microscopy & Microanalysis 2020

August 2–6, 2020
Milwaukee, WI
www.microscopy.org

More Meetings and Courses

Check the complete calendar near the back of this magazine.

Carmichael's Concise Review

How an Ant Cleans its Antennae

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Most insects, including ants, depend on sensory input from their antennae for survival: obtaining food, finding mating partners, and avoiding predators. Contamination of the surfaces of the antennae, both by abiotic contaminants (dust, salt, ash, etc.) and biologic contaminants (bacteria, spores, parasites, etc.), can interfere with the function of the sensory systems and therefore be life-threatening. Insects have developed a variety of mechanisms to cope with surface contamination. In addition to passive cleaning mechanisms such as equipping the body surface with super-hydrophobic material (as exhibited by the leaves of the lotus flower, known as the “lotus effect”) insects actively groom their body surface with specialized cleaning structures on their legs. These cleaning activities take up to 30% of their lifetimes! Insect grooming movements have been classified as “rubbing” where cleaning is performed by an appendage sweeping back and forth, “scraping” with unidirectional movements performed by a cleaning structure, and “nibbling” where cleaning is performed by the insect’s mouthparts. Recently, Alexander Hackmann, Henry Delacave, Adam Robinson, David Labonte, and Walter Federle used scanning electron microscopy (SEM) to study the functional morphology of the antenna cleaner in *Camponotus rufifemur* ants [1]. In addition they quantified the efficiency of the cleaner apparatus.

During an antenna cleaning movement, the ants lower their head, insert their antenna into a clamp-like cleaning structure on the front leg of the same side, and pull it through. After the actual grooming movement, the antenna cleaner is then cleaned by the ants’ mouthparts (nibbling) in order to allow reuse. The cleaning structure in almost all ant species consists of a curvature on the front tarsus (called the tarsal notch) that faces a spur originating from the tibia. Each side of the clamp bears hair arrays that can be subdivided into “bristles,” “combs,” and “brushes” that are outgrowths of the cuticle (Figure 1).

Hackmann et al. simulated cleaning strokes by moving a notch and a spur over antennae contaminated with fluorescent particles of different sizes. The notch

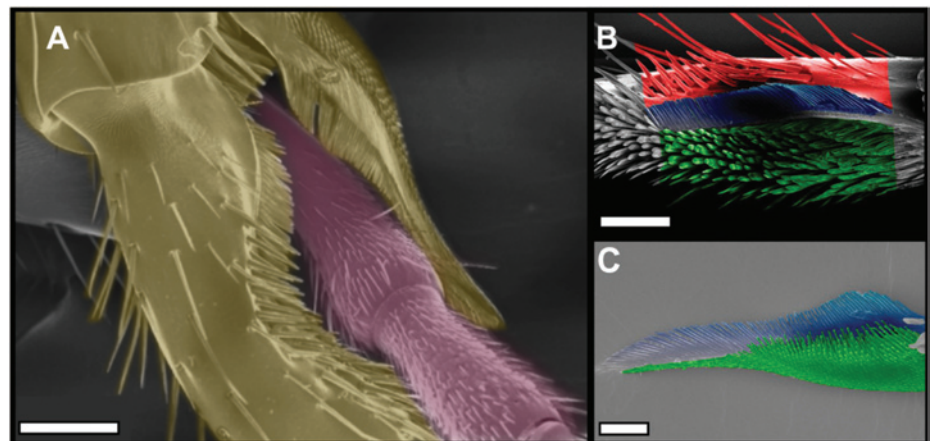


Figure 1: Antenna cleaner of *C. rufifemur* ants. (A) Scanning electron micrograph of the antenna clamped by the cleaner (viewed from the outer or posterior side). (B) Tarsal notch. (C) Tibial spur. Images in B and C are colored to show the bristles (red), the comb (blue), and the brush (green). Scale bars: (A) 150 μm , (B) 100 μm , (C) 50 μm .

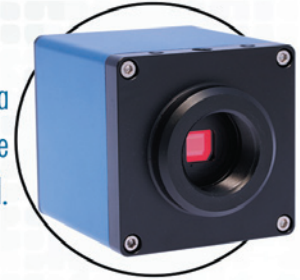
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removed particles more efficiently than the spur, but both components removed more than 60% of the particles with the first stroke. Ablation of the bristles greatly reduced the cleaning efficiency, indicating they are essential for cleaning. Different-sized particles were trapped in distinct zones of the notch, proportional to the gap between the bristles. This suggests that the antenna cleaner operates as a sequential particle filter. The bristles pick up the largest particles from the antenna, and the comb removes particles that are smaller than the gaps between the bristles but larger than the gaps of the comb. In addition, there are flexible setae forming a brush that picks up even smaller particles. Whereas bristles and combs removed larger particles mechanically, the brush setae remove dirt particles by adhesion. The sequential particle filter mechanism prevents the very fine setae from being clogged by larger particles that have already been removed by the previous hair arrays. This is a fascinating mechanism that is essential for the survival of the ant, and its principles could inspire artificial cleaning devices for cleaning man-made surfaces on a micro- and even nano-scale.

References

[1] A Hackmann et al., *Royal Society Open Science* (2015) <http://dx.doi.org/10.1098/rsos.150129>.
 [2] The author gratefully acknowledges Dr. Alexander Hackmann for reviewing this article.

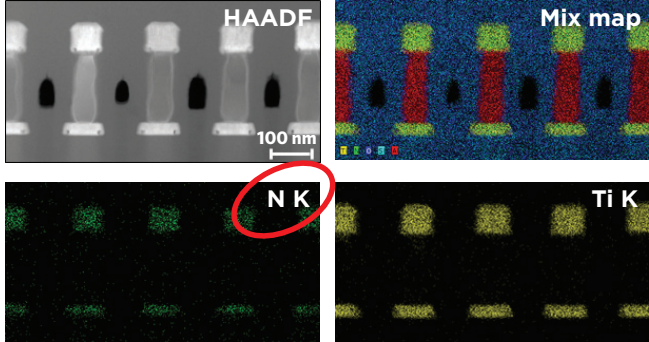
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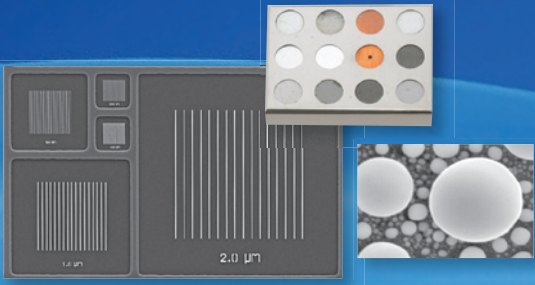



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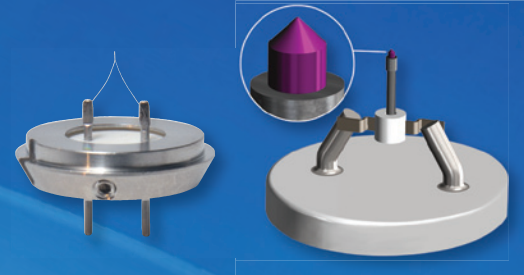
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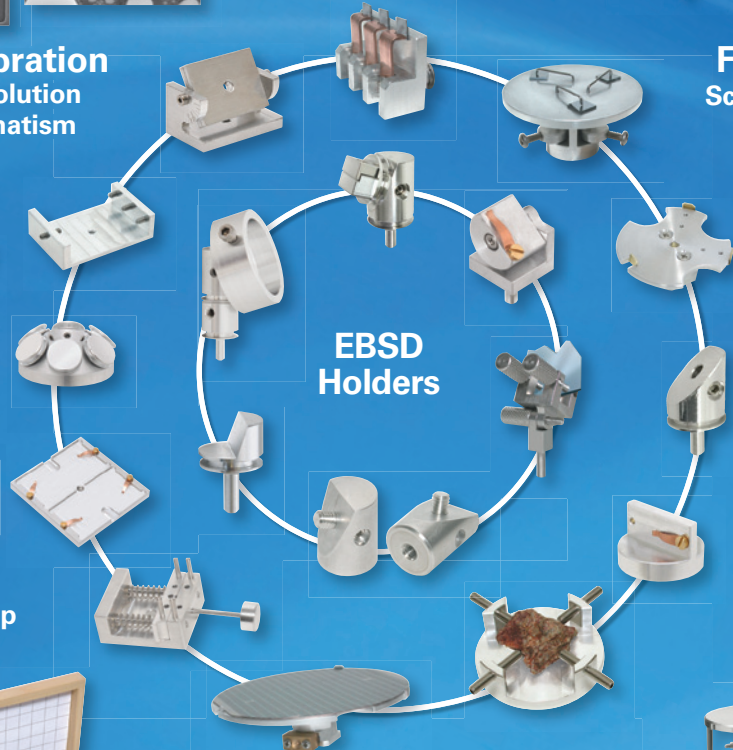
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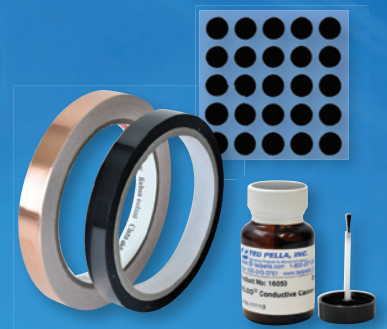
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