

Inspiration from functional biomaterials in honeybees and elephants: Development of miniaturized devices for navigation and water detection

O. Futterknecht^{1,2}, M.O. Macqueen², S. Karman^{3,4}, S.Z.M. Diah³ and Ille C. Gebeshuber^{1,2,3}

¹ Institute of Applied Physics, Vienna University of Technology, 1040 Wien, Austria

² Aramis Technologies Sdn. Bhd., 57000 Kuala Lumpur, Malaysia

³ Institute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Malaysia

⁴ Department of Biomedical Engineering, University of Malaya, Kuala Lumpur, Malaysia

Smart usage of energy is one of the keystone properties of living systems. Honeybees for example use the changing polarization pattern of the skylight over the day for orientation and navigation. Also people increasingly rely on navigation devices and have already developed various effective ways for ground navigation. But there are different problems with current GPS-systems: they are battery dependent, and since they are controlled by the military they can be blurred or even switched off at any time. Honeybees actually see the polarization pattern of the skylight with a specialized area located in their compound eyes. Based on the structure and function of this highly efficient biomaterial, we have developed concepts for small and energy efficient microelectromechanical systems (MEMS). The device can be embedded in sunglasses (similar to the Google Glass®), with the necessary electrical power being provided by solar panels.

A concept for an efficient miniaturized device for water vapor detection has been developed inspired by aquatic insects such as the *Heteroptera* (true bugs), some of which, e.g., *Sigara* (a genus of aquatic insects) need to locate water habitats for their reproduction circle. *Sigara* uses the polarization pattern in order to find water habitats.

Also infrasound signals produced by underground rivers can be used for the location of water. Inspiration for a related device comes from elephants who use infrasound to detect underground water. Water can also be detected by analyzing minute temperature differences, utilizing the infrared spectrum of light.

The presentation will introduce the inspiring organisms, their highly specialized functional biomaterials, biomimetic concept developments and an outlook touching upon the potential of sustainable miniaturized technology using environmentally friendly bioinspired materials, structures and processes.