Analyzing the tribological combination of microstructure and lubricant in beetle joints for the development of environmentally friendly lubricants

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Insects optimize friction in their joints by combining microstructures with a – so far unknown - lubricant. To develop environmentally friendly lubricants, we research the sophisticated tribological system found in the joints of beetles. We characterize the lubricant as well as the microstructure of the joints to gain inspiration for the development of a degradable and – hopefully – superior alternative to mineral-oil-based lubricants. However, restrained by the tiny quantities of the beetles' lubricant and the compactness of their joints, the tribological analysis is challenging. Therefore, we apply atomic force microscopy (AFM) to record the joints' microstructure and the lubricant's frictional properties. Furthermore, we researched the inner structure of the bearing surface in the beetle's joints by focused ion beam (FIB) tomography. With this approach, we discovered the network of channels supplying the lubricant to the pores, which represent the inlets of the hinged joint system. As a subsequent step, we analyze different types of plant mucilage at present using AFM friction measurements to compare the suitability of plant mucilage as an alternative lubricant to the tiny quantities of the beetle's lubricant. Finally, we are developing an artificial surface mimicking the microstructure of the beetles' joints. We determine its frictional properties utilizing colloidal AFM probes in the dry state as well as the lubricated state with plant mucilage as a lubricant.

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