Biotribological model systems for emerging nanometer scale technologies

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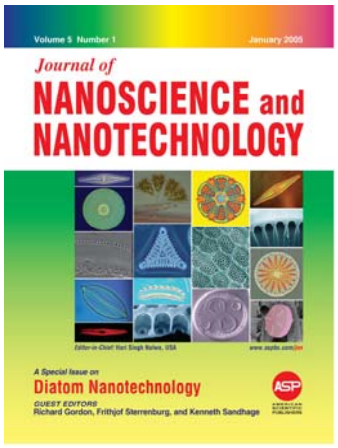
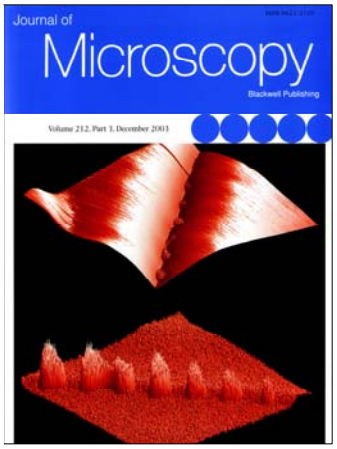
Abstract

Technological devices such as pressure sensors, gyroscopes and accelerometers get smaller and smaller. This increases the necessity for the fundamental understanding of tribological phenomena at the micro- and nanometer scale. Biological systems excel also at this scale.

The thesaurus that nature has developed during the last millions of years of evolution comprises self-cleaning surfaces, systems with friction coefficients smaller than any occurring in man-made systems and organisms that produce macromolecules with ice binding properties. Such systems with well adapted biotribological properties shall serve as inspiration for innovation in micro- and nanotechnology.





Tribology
Tribology is the branch of engineering that deals with the **interaction of surfaces** in relative motion (as in bearings or gears):
their **design**
friction
adhesion
lubrication and **wear**.


© WSW Bearings, China

Biotribology
The aim of biotribology is to gather information about friction, adhesion, lubrication and wear of **biological systems** and to apply this knowledge to technological innovation as well as to development of environmentally sound products.

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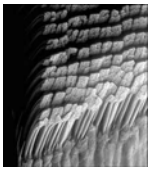
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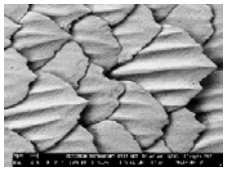
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This new interdisciplinary field of research combines methods and knowledge of physics, chemistry, mechanics and biology.

Why bio*micro* and -*nano*tribology ?
Continuous **miniaturization** of technological devices like hard disk drives and biosensors increases the necessity for the fundamental **understanding** of tribological **phenomena at the micro- and nanoscale**.
Biological systems excel also at this scale and therefore their strategies can serve as templates for new engineering devices.

Diatoms
- size some micrometers
- single cellular organisms
- reproduce via cell division
- 10 000s species, since 180 millions of years
- under ideal conditions, within ten days the offspring of one single cell number is one billion cells → assembly line production of nanostructures !
- nanostructured surfaces made from amorphous silicates


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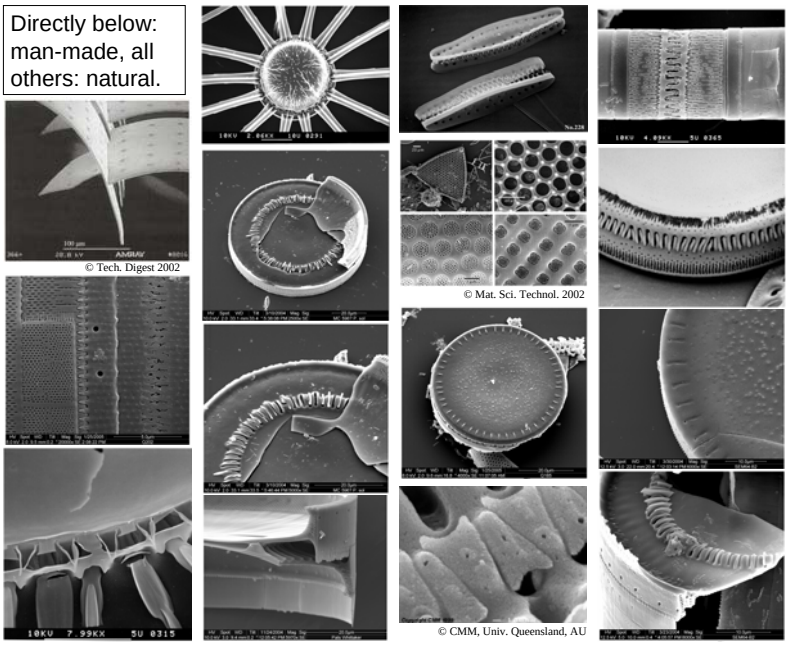
Directly below: man-made, all others: natural.



The diatom SEM images above show various means by which neighbouring cells and even different components of the same cell wall interlock. In each case, biological membranes lie between the two components during formation but on maturity that is lost leaving silica against silica. In one case, bottom left and top left, siliceous spines are attached to the wall in a moveable hinge.

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