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Diatoms as Model Systems for Advanced MEMS Tribology and Corrosion Resistance

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Biomimetics of diatoms offers a promising avenue for advancing microelectro-mechanical systems (MEMS), particularly by leveraging their unique tribological properties. Diatoms, unicellular algae, construct intricate houses of hydrated silica, featuring rigid components in relative motion facilitated by natural hinges and interlocking devices. Over millions of years, diatoms have evolved sophisticated tribological mechanisms to address challenges similar to those faced by modern 3D MEMS, which are plagued by issues of friction, adhesion, corrosion and wear.

Current 3D MEMS, despite significant technological advancements, continue to grapple with tribological problems at the micro- and nanoscale. Diatoms, operating at a comparable length scale, provide an invaluable model for overcoming these challenges. Of particular interest is the polar diatom species *Corethron criophilum*, which thrives in cold water environments. These diatoms grow their silica shells efficiently with minimal material, yet exhibit highly refined tribological properties, far surpassing those of diatoms in warmer conditions.

By studying *Corethron criophilum*, we gain insights into the development of microstructures that optimize material usage while enhancing tribological performance. These diatoms demonstrate how Nature achieves remarkable friction and wear management through microstructural adaptations, a principle that can be directly applied to the design and fabrication of MEMS. The ability to emulate the natural solutions of diatoms holds the potential to revolutionize the field of nanotechnology and tribology, leading to more reliable, efficient and durable MEMS.

This research underscores the importance of biomimetics in the advancement of tribological applications within MEMS technology. By integrating the lessons learned from the polar diatom *Corethron criophilum*, we aim to address the critical issues of material efficiency and tribological optimization in MEMS. Our interdisciplinary approach, combining physics, biomimetics, tribology and nanotechnology, sets the stage for groundbreaking innovations that harness the evolutionary wisdom of diatoms for cutting-edge technological applications.

The study of diatom biomimetics, particularly focusing on the tribological properties of species that thrive in extreme environments such as *Corethron criophilum*, offers a novel and effective strategy for overcoming the persistent challenges in MEMS technology. This work highlights the potential of Nature inspired solutions and paves the way for the development of next-generation MEMS with superior performance and longevity.