Understanding frictional mechanisms in Carbon-based systems in dry and lubricated conditions

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Tribological contacts contribute significantly to global energy consumption, accounting for 23% (119 EJ). Graphite layers have been model systems in achieving ultra-low friction in dry friction scenarios, paving the way for structural superlubricity. Previous studies have also showcased superlubricity in fluids, using dedicated lubricants, igniting interest in practical applications. The challenge lies in sustaining superlubricity under specific conditions for prolonged lubrication.

In this presentation, we will present experiments on graphite used as solid lubricants under dry conditions [1,2], where we investigated the lubricating mechanisms under high mechanical loads. In parallel, we also performed tribological tests with various model lubricants (e.g., glycerol), materials (e.g., ceramics), and coatings (e.g., a-C:H and ta-C) using a ball-on-three plate geometry. Promising candidates then underwent application tests on a plain bearing tribometer. Integrating experiments with surface analyses and molecular dynamic simulations enabled the identification of tribological mechanisms and allowed to compare similarities and differences of dry and lubricated superlubricity.

[1] C. Morstein, A. Klemenz, M. Dienwiebel, M. Moseler, Nature Comm. 13, 2022
[2] T. MacLucas, et al, ACS Applied Nano Materials 6, 1755-1769 (2023)