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Atomic Scale Mechanisms of Friction Reduction and Wear Protection by Graphene

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A conscious handling of energy and materials has become a major demand to ensure a sustainable future of our planet. In this context not only the production of environmentally friendly energies and materials are crucial, but also their efficient use. Modern tribology can help to minimize mechanical losses due to friction and maximize lifetime of components by reducing wear. In recent years graphene based materials and lubricant additives have attracted considerable attention because of their potential to build superlubricious and low-wear tribological systems.

In this contribution the frictional and wear behavior of graphene-covered Pt(111) surfaces has been inferred using nanoindentation and nanoscratching employing atomistic computer simulations as well as friction force microscopy experiments [1]. We find elastic response of the system at low load, plastic deformation of Pt below the graphene at intermediate load, and eventual rupture of the graphene at high load. Friction remains low in the first two regimes, but jumps to values also found for bare Pt(111) surfaces upon graphene rupture. While graphene substantially enhances the load carrying capacity of the Pt substrate, the substrate's intrinsic hardness and friction are recovered upon graphene rupture. The results indicate that coating metals with graphene can increase their plowing resistance resulting in wear and friction reduction provided the applied load are small enough to prevent the graphene from rupturing.

[1] A. Klemenz, L. Pastewka, S. G. Balakrishna, A. Caron, R. Bennewitz, M. Moseler, Atomic Scale Mechanisms of Friction Reduction and Wear Protection by Graphene, **Nano Letters** 14, 7145 (2014)

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