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Superlubricity of ta-C: A Systematic Study of Friction and Wear in the Ultra-low-friction Regime of Hydrogen-Free Tetrahedral Amorphous Carbon Coatings

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Due to high hardness and chemical inertness amorphous carbon, or DLC, shows favourable tribological properties as a coating material by reducing friction and wear. Two different types of improving mechanisms can be observed.
The first one applies to most kind of DLC and is attributed mainly to high chemical inertness of the carbon surfaces opposing a steel counterpart. The properties of the lubricant have little influence only.
Furthermore, another much stronger friction-reducing effect, sometimes referred to as superlubricity, is described in literature for tetrahedral amorphous carbon (ta-C), specifically. Friction coefficients have been reported in the ultra-low-friction regime and are significantly lower than in a comparable conventional friction system. It is assumed that superlubricity occurs on a chemicially reacted tribofilm which forms on ta-C with specific lubricants exclusively.
In this study the low friction phenomenom was studied systematically by varying sp^3-content of the amorphous carbon, temperature, sliding motion, and chemical functions of the lubricants. A clear dependency of low friction with respect to sp^3-content and temperature was found: The higher the temperature and thesp^3-content, the lower the friction. Besides lubricants known from literature new substances were identified that cause superlubricity. Systematic variations of fatty acid derived lubricants indicate a chemical reaction of the lubricant in the tribological contact. Whereas the friction reducing effect has been investigated and described in literature, little attention has been paid on wear so far. In this work wear performance was studied in comparison with friction. While some tribo-systems in the low-friction state showed no wear, others showed extremely high wear. Both chemical functions of the lubricant and sp^3-content of the amorphous carbon have been identified as influential factors.

Keywords
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