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Velocity-dependence of tribologically-induced oxidation of high-purity copper

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ABSTRACT
Tribochemical reactions are an often observed phenomenon during friction and wear processes, ranging from daily life applications such as medical implants to industrial applications such as fretting corrosion. Among various tribochemical reactions, tribo-oxidation is a far from fully understood mechanism, taking place by tribochemical reactions of the tribo-partners or the surrounding medium. Our research aims to elucidate the elementary mechanisms of tribologically-induced oxidation by paring polycrystalline high-purity copper plates with sapphire spheres. The experiments are performed under mild tribological loading at room temperature in a strictly controlled atmosphere with reciprocating linear sliding.

Our results show an oxidation process of the sample surface with rates order of magnitudes faster than the native oxidation of copper under the same environmental conditions and without tribological loading. With increasing sliding cycles we found the formation of amorphous oxygen-rich cuprous-oxide (Cu_2O) islands formed below the surface and grown to hemispherical amorphous/nanocrystalline cuprous-oxide clusters [1]. After the islands have grown, they coalescence and form a continuous oxide layer on the surface, determining from then on the tribological properties of the contact. This works intends to understand the influence of the sliding velocity on the formation of these oxide clusters. We systematically vary the sliding speed from 0.1 to 5.0 mm/s and investigate the resulting microstructure. Furthermore, we increase the exposure time of the sample to the controlled environment after the tribological loading since we relate the growth of the clusters to the diffusion of oxygen in and on copper. With help of different exposure times, we investigate the diffusion properties of the oxygen within the plastically deformed microstructure. Scanning electron microscopy techniques are further used in order to reveal the fundamental mechanisms of tribologically-induced oxidation.

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REFERENCES
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