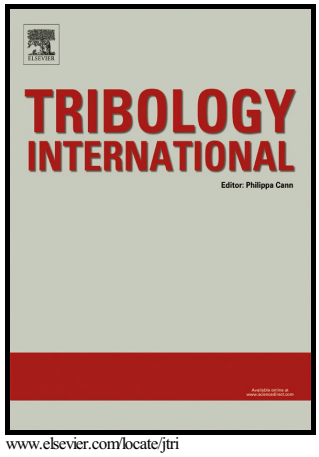

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Nano-indentation mapping of fretting-induced surface layers

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Abstract

Tribologically modified surface layer results from the energy dissipated in the frictional contact area. This layer usually has a different elastic modulus and hardness from the substrate, and its structure corresponds to the intermediate stage between a material of the first-body and debris of the third-body. Even though, the existence of the tribologically transformed structure in the fretting contact has been well proven, the formation and mechanical transformation mechanisms are still not clear. Hence, in this paper, evolution of mechanical properties of four metallic materials (titanium alloy, stainless steel, carbon steel, copper alloy) induced by fretting was investigated using nano-indentation mapping of the fretting wear scars. It was shown that the tribologically transformed structure formed very quickly within the initial fretting cycles, and its mechanical properties remained almost constant during the entire test duration for tested materials. However, it was observed that all materials responded differently to the frictional energy, exhibiting particular rate of change of the H/E ratio before and after the fretting experiment. Modified XRD technique was used to probe the friction induced changes within the small spots of the fretting scars, and revealed distinctive structural modifications within the transformed layers. The approach proposed in this study can be used to inform the predictive wear models, by providing information about the evolution of the mechanical properties of the tribo-system with time.