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Tribocorrosion behaviour of noble alloys

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Gold is considered a noble metal due to its chemical inertness and resistance to oxide formation within the stability potential window of water. However, gold is very soft, and it is commonly alloyed with other metals (copper, silver, zinc) to improve its mechanical properties. The use of less noble alloying elements such as copper or silver, may lead to a preferential dissolution of those elements and potentially modifying the original properties of the gold alloy. Above the risk of selective dissolution, which has been previously studied, when gold alloys are subjected to a tribological contact in a corrosive environment, tribocorrosion degradation may occur. This talk aims at assessing the tribocorrosion behavior of a gold alloy during sliding against an alumina counterpart in a NaCl electrolyte. To do that, a ball on flat configuration was used under well controlled mechanical (1.5N normal load and 10 mm/s sliding speed) and electrochemical (Open Circuit Potential conditions and applied potential) conditions. After the tribocorrosion tests, 3D confocal microscopy, Scanning Electron Microscopy (SEM) and Auger Electron Spectroscopy (AES) was carried out to quantify wear and identify the degradation mechanisms.
During the tribological contact, gold alloy plastically deforms and ploughs. Wear occurs during the first cycles and once a certain deformation is reached, the cyclic sliding generates material smearing and a decrease in wear. On the other hand, at the onset of sliding a potential decay of around 150 mV was observed in the tests carried out at OCP and a current increase under potentiostatic conditions. This indicates a wear accelerated corrosion of the gold alloy by the mechanical action. At the end of the tribocorrosion tests, the worn surfaces showed an enrichment in gold and a high copper depletion over more than 20 nm of depth. The wear patterns were interpreted by a mechanism of mechanical mixing which continuously brings copper to the surface and preferentially dissolves.

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