STUDIES OF ELECTRON TRIBOEMISSION FROM FRICTIONAL CONTACTS: MECHANISMS AND MODELING

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The authors have carried out extensive measurements of electron triboemission from the scratching and sliding of selected ceramics and of semiconductors in high vacuum. Triboemission of electrons is observed under conditions of tribological contact, and it is apparent that important fractions of the electron outputs are emitted for energies lower than the electron work function (WF) of the bulk materials. Low-energy triboemitted electrons play a significant role in tribochemical reactions under boundary lubrication conditions, and in mechanochemical processes; connections have been made between relevant tribochemical reactions and triboelectron emission [1]. Another reason to study triboemission is the lack of experimental probes for the wear process in real time. Although the origin of triboemission is not yet clear, the authors showed that triboemission features clearly relate to worn surface evolution.

Measurements are presented of typical burst-type electron triboemission from an alumina ball or a diamond cone scratching alumina, sapphire and silicon nitride, and the semiconductors Si and Ge. Sliding contacts of insulators produce large bursts of electron triboemission, which are superimposed to lower but seemingly constant levels of emission over repeated passes on the same wear-track. Other key findings on triboemission are the absence of semiconductor triboemission after the contact ceased when compared to significant post-contact triboemission from insulators, much lower levels of positively-charged emission from insulators, and that diamond scratching of aluminum does not produce significant triboemission [1].

Analysis techniques were developed for triboemission data: frequency plots of data revealed characteristic patterns in the frequency domain. Molina et al. also studied different probability distributions for fitting to such triboemission data. A stochastic process (i.e., the Thomas' process) can be fit if assuming a two-stage sequence of electron production, where wear may evolve to match such sequence and distribution. A recent interpretation postulates that reduction of WF due to plastic deformation and increased dislocation density during sliding, and the surface charging are essential to electron triboemission from insulators [1]. This mechanism is consistent with (a) the triboemission data during both contact and after-contact emission from insulators and semiconductors and (b) with the triboelectron-energy measurements. Finally, the feasibility is presently explored of randomness vs. deterministic origins for the triboemission outputs. The authors believe that understanding of triboemission and related mechanisms is key to modeling of frictional processes for insulators, mainly ceramics, semiconductors, and for development of novel lubrication solutions.

References

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