Wear Resistant Material Pairs for Sliding Electrical Contacts

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ABSTRACT

In electromagnetic launchers, armature wear volumes may exceed that providing interference with the bounding rails and solid-on-solid electrical contact. Loss of contact results in arcing transition which damages the rails and affects the longevity of the launcher. For their high electrical conductivity, copper and aluminum are the generally selected materials for the rails and the armature, with the low density of aluminum making it particularly attractive for armatures of reduced parasitic mass. Modeling of armature melt wear based on simple thermal models is used here to predict how different material combinations will partition the interfacial power that is generated at the armature-rail contact by Joule heating. A parameter termed Armature Melt Resistance (AMR) is identified as a 'figure of merit' parameter considering both rail and armature thermophysical properties, for which greater values predict lesser extents of armature wear. Armature materials with high values of AMR when paired with copper rails are evaluated as both press-fit surface claddings and coatings applied to aluminum bulk armatures to maintain low armature mass. Molybdenum clad armatures demonstrated provisional success with transition-free launches, while plasma sprayed coatings of molybdenum, nickel, and their mixtures experienced repeated failures with coating delamination. Using molybdenum rails and various armature materials of equal or less melt temperature, a condition of the presented thermal model that was not met in earlier studies against copper rails, a range of AMR values are evaluated by measurements of armature wear volumes. It is shown that a modification to the AMR parameter to include the resistivity of the armature and rail materials more accurately predicts rank-order of armature wear volume.