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Theory of metal/metal multi-contact interfaces: Implications of the coupling between the electrical and thermal transfer processes

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Many industrial applications, such as power transfer systems for train propulsion or mechanical contact between solid surfaces, involve multi-contact interfaces (MCI). This challenging field has attracted the attention of many researchers and engineers attempting to build a complete and coherent description of such interfaces. This field offers a natural framework for complexity studies since MCI involve both tribological, mechanical and physical processes intimately intricated at different scales. Through the strong coupling between different classes of properties, that complexity is also the main obstacle towards a comprehensive understanding of the Physics of MCIs. In accordance with the common trends in the field, we propose a theoretical approach to the electrical transport through metallic MCIs, treated as a discrete collection of a large but finite number of contacting asperities (mechanical spots due to surface roughness), and taking into account its natural coupling with thermal transfer. A first one-spot model is derived, leading to the temperature (current) dependence of the constriction resistance of individual spots. We predict a critical current depending on the spot size and thermal conductivities of the metal pieces and controlling the transition to a highly resistive state of the interface. Extension of the model to a many spots interface is briefly discussed. The results are finally confronted with experimental data regarding a two-bead system revealing a very good agreement with the model. Implications of the model on the mechanism of the so-called Branly effect are also discussed along with the likely influence of tunneling between the contacting solids.

Biography

N Foy is actually completing his PhD thesis dedicated to the theoretical, numerical and experimental studies of the contact between metallic bodies under severe mechanical compression, paying a special attention to their applications to railway transport (power supply-train propulsion).

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