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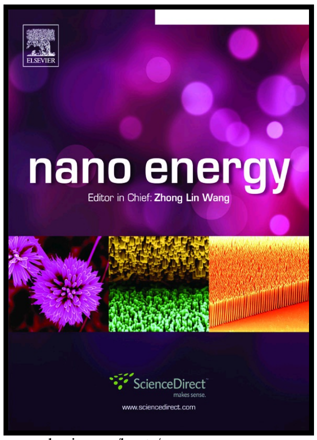

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Theory of contact electrification: Optical transitions in two-level systems

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Abstract

The increasing need to power networks of trillions of sensors and devices for the Internet of Things requires effective generators to harvest low-frequency ambient mechanical vibrations. This type of energy is different from conventional power because it is mobile, widely distributed and involves the coupling of a huge amount of units. Triboelectric nanogenerators are ideal candidates for this purpose and can provide power densities up to 500 W/m^2 or 15 MW/m^3. While the phenomenon of triboelectricity has been known and explored since ancient history, a detailed microscopic understanding is still under debate. Recent experimental study has proposed a general model in which triboelectrification may be a result of electron transfer between two atoms owing to the lowered barrier due to overlapped electron clouds (Xu et al.[13]). Here, we provide, in the context of the proposed triboelectric model, a first quantum-mechanical calculation of electron transfer and light coupling between two dissimilar atoms interacting at a distance based on the one-electron Schrödinger model and the Fermi Golden Rule. Static and dynamic studies of contact electrification and photon emission between two groups of atoms are also analyzed. Despite the model's simplicity in addressing coupled atoms it may set the frame for a better understanding and exploitation of charge transfer in nanotriboelectric systems consisting of many atoms or solids.