Description of Transport Phenomena in Molecular Compounds: An Alternative Approach to Generalize Hopping Mechanism

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This communication deals with the subject of different physical transport phenomena, where a key quantity is the activation energy as temperature dependent. Although transport phenomena in these kinds of materials are usually dealt with the Arrhenius or Hopping mechanism, which predicts that the transport rate is an exponential function of the inverse of the temperature, many experimental researchers have recently reported non-hopping temperature dependency in the ions' diffusivity. In these materials the logarithm of the diffusivity, plotted against the reciprocal of the absolute temperature, exhibits a deviation from linearity. It is also important to highlight that many experiments across a range of fields present non-exponential behavior, such as diffusion, rate reaction in chemistry and biology processes super- and semi-conductors, non-linear resistors and various transport phenomena in materials science. In the light of existing problems in this subject, the main objective, in this work, is to propose an alternative approach to generalize non-Mott or variable range hopping mechanisms. In summary, we try to answer the question: do ion transport mechanisms, as function of the inverse of temperature, follow exponential or power law decay function? The answer of this question and the validation of the proposed model were performed based on the following temperature-dependent ion transport mechanisms: non-linear conductors, super- and semiconductors materials, thermally activated conduction, ion transport in a disordered semiconductor and in amorphous solid, low-temperature conduction in strongly disordered systems, nearest-neighbor hopping processes, metal-insulator-metal conductivity, hopping conductivity in polymer matrix–metal particle composites, electrical conductivity on GaMn material, high temperature variable-range hopping conductivity in undoped TiO_2 thin film, hopping conduction in PAni/PSS blends and others cases. For different cases of ion transport mechanism, we found that the conductivity processes are well described by the power-law decay, rather than the exponential one.

Keywords: Transport Phenomena, Hopping Mechanism, d-exponential functions, non-Arrhenius models, non-linear conductors, semiconductor,supercondutor

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