Abstract

Far from Equilibrium Dynamics in Nonlinear Percolative Composites

Asok Kumar SEN[¶], Somnath BHATTACHARYYA, Partha Pratim RAY

Theoretical Condensed Matter Physics (TCMP) Division
1/AF, Bidhannagar
Kolkata 700064
India

asok@cmp.saha.ernet.in

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To explain the non-linear current-voltage characteristic along with a ultra-low percolation threshold in a variety of composites, granular, dispersed metallic physical and even some biological systems (at quite low voltages), we had proposed in the early-90's [1], a semi-classical (or, semi-quantum) model for percolation in the presence of tunneling bonds. This tunneling over barriers (absent in classical physics) is the ONLY way in which quantum mechanics enters our study. Further, this is obviously a case of a driven system, as well as that of a 'soft condensed matter,' since the external driving force is quite 'low'. The main feature in this model is to allow tunneling between two nearest neighbour metallic bonds (randomly thrown). As such this model may also be viewed as a totally correlated bond percolation model. Obviously, we call this as a Random Resistior cum Tunneling Network (RRTN) model. We did study percolative properties and both dc and ac nonlinear response in this model [1–3].

Further, the dielectric breakdown and the related exponent [4], and the Variable Range Hopping (VRH) at 'low' temperatures [5] have also been studied in the RRTN model.

In this Conference, we report on our detailed study of the non- equilibrium dynamics in our model and find some avalanche-like behaviour with initial power-law style decays or growths. With two different power-law style decays in the beginning, it has a lot of similarity with the some studies on real earthquakes.

1 On a New Percolation in the Presence of Tunneling Bonds. A. Kar Gupta and Asok K. Sen, International Centre for Theoretical Physics (Trieste, Italy) refereed Preprint No. IC/ 94/ 212 (1994). A slightly modified version was later published as: A. Kar Gupta and Asok K. Sen, Physica A 215, 1 (1995).

2 Nonlinear DC-response in Disordered Composites: a Percolative Study. A. Kar Gupta and Asok K. Sen, Phys. Rev. B 57, 3375 (1998)

3 Frequency-dependent Conduction in Disordered Composites: a Percolative Study. Asok K. Sen and A. Kar Gupta, Phys. Rev. B 59, 9167 (1999)

4 Aspects of Dielectric Breakdown in a Model for Disordered Nonlinear Composites. A. Kar Gupta and Asok K. Sen, Physica A 247, 30 (1997)

5 Temperature-dependent Conduction in Composites: a Percolative Approach (with A. Kar Gupta and D. Dan*). Ind. J. Phys. A 71, 357 (1997)

[¶]Presenter