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Universality and the thermoelectric transport properties through a single electron transistor

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We discuss the temperature-dependent thermoelectric transport properties of semiconductor nanostructures comprising a quantum dot coupled to quantum wires, that is, the thermal dependence of the electrical conductance, thermal conductance, and thermo power. The physics of electrical and thermal conduction through the nanostructures is controlled by the antiferromagnetic interaction between the magnetic moment of the dot and the spins of the conduction electrons in the wires. At low temperatures, the conduction electrons tend to screen the dot moment, which gives rise to the Kondo effect. We explore the universality of the thermo-electric properties in the temperature range governed by the Kondo crossover. In this thermal range, general arguments indicate that the temperature dependence of any equilibrium property should be a universal function of the ratio T/TK, where TK is the Kondo temperature. Experimental work has nevertheless failed to identify universal behavior. On the theoretical front, the zero-bias electrical conductance through a quantum dot embedded in a quantum wire and the conductance through a quantum wire side-coupled to a quantum dot has recently been shown to map linearly onto the universal conductance for the particle-hole symmetric, spin-degenerate Anderson model. Here we extend this result to the other thermo-electric transport properties, the thermo power, and the thermal conductance. Our analysis relies on rigorous renormalization-group arguments. Illustrative numerical renormalization-group results are presented in order to illustrate the physics in our findings.

Biography

Roberto Franco Peñaloza has completed his Bachelor and Master degree in Physics at the Universidad del Valle (Cali - Colombia), obtained his PhD in the Physics Institute of the Federal Fluminense University from Niterói - Rio de Janeiro (Brazil) and did Postdoctoral studies at the Physics Department of the Catholic University of Rio de Janeiro. He is Associated Professor at the Physics Department of the Colombia National University - Bogotá, and has more of 50 publications in different International Journals about Condensed Matter Physics.

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Degradation in organic solar cells: A quantitative analysis

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Tremendous efforts have been made in improving the efficiency of organic solar cells; however, a systematic study to stabilize the solar cells still remains the need of the hour. The solar cells of ITO/PEDOT: PSS/Active layer/Al were fabricated and studied. The cell performance not only depended on the device architecture, but lowering of V_{OC} and J_{SC} with time could also be co-related with the shift in energy levels of active layer and work function of Al and ITO electrodes. The theoretical modelling to fit the experimental results indicated that as time passes, the activity at the electrode junctions becomes important and the junctions deteriorate. Thus, the interfaces start playing a dominant role leading to creation of new interface states (increase in density of states from 9×10^{11} to 1×10^{13} $cm^{-2}eV^{-1}$), increase in thickness of interface layer from 8 Å to 13 Å, and change in HOMO-LUMO levels of active layer. Lowering of mobility (from ~ 10^{-5} to 1×10^{-7} $cm^2V^{-1}s^{-1}$) and carrier lifetime was also responsible for degradation. The hole extracting layer, PEDOT: PSS, was incorporated with MWCNT to improve the efficiency. Though the conductivity of PEDOT: PSS increased by an order of magnitude, but similar degradation patterns were observed as was for pristine solar cell. Degradation of PEDOT:PSS is mainly due to hygroscopic PSS. Therefore, the devices kept in vacuum and nitrogen gas environment showed better stability, i.e., approximately 80%, 50% and 40% fall in initial efficiency, respectively for devices kept in air, vacuum and nitrogen gas. MWCNT in the active layer (P3HT: PCBM) stabilizes the cell performance in contrast to pristine cell by ~ 20%. Further, PCDTBT: PCBM based solar cells were also investigated for stability and lifetime studies.

Biography

Swati Arora did her PhD in thin films photovoltaic solar cells from University of Delhi in 1991, and is presently working as Associate Professor in University of Delhi. She has about 30 years of research experience. She was also associated with teaching and research work at EIT (Africa) and was Editor-in-Chief for the *"Science Vision magazine"* for popularization of science there. She has published a number of research papers in the International Journals/Conferences and is a part of several research projects. Her major field of interest is thin films solar cells and their degradation studies.

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