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Fluctuation-Induced Tunneling Conductivity in TiO_2 Nanoparticle Thin Films[1] STEVEN J. KONEZNY, CHRISTIAAN RICHTER, ROBERT C. SNOEBERGER III, ALEXANDER R. PARENT, GARY W. BRUDVIG, CHARLES A. SCHMUTTENMAER, VICTOR S. BATISTA, Yale University — We integrate temperature-dependent dark DC conductivity measurements and theoretical modeling to elucidate the mechanism of electron transport in nanoporous TiO_2, a common photoanode material for dye-sensitized solar cells (DSSCs) and solar photocatalysis. We show that fluctuation-induced tunneling conduction through contact junctions between sintered TiO_2 nanoparticles can account for the temperature dependence over the entire temperature range studied. We find quantitative agreement between experimental and calculated conductivities, which span over four orders of magnitude and change with decreasing temperature from thermally activated to temperature-independent. The reported results suggest that efforts to optimize charge transport in nanoporous TiO_2 thin films as a means of improving the overall efficiency of DSSCs and solar photocatalysis should focus on fabrication conditions that optimize the properties of the contact junctions between sintered TiO_2 nanoparticles.

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