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Long-range potential fluctuations in thin-film photovoltaics MUTHUTHANTHRIGE LILANI COORAY, VICTOR G. KARPOV, The Department of Physics and Astronomy, The University of Toledo, Toledo, OH 43606, USA — A quantitative theory is developed to describe the long-range potential fluctuations caused by random charges in thin semiconductor structures sandwiched between two electrodes representative of thin-film photovoltaics. The semiconductor contains localized electric charges of impurities, grain boundary defects, etc. The device thickness is smaller than the screening length of its constituting bulk material; hence, the film behaves as a dielectric. In particular, variations in charge density will create the random electric potential not limited by the film screening length l. Instead, the electrons in the electrodes will redistribute to maintain the electrode equipotentiality thereby providing the electrostatic screening. We have shown that in such systems, the lateral space scale of random potential is close to the structure thickness. The random potential amplitude is described analytically and is specified for three practically important cases of point defects, spherical grains, and columnar grains causing the potential fluctuations. The implications of our theory are pointed out suggesting practical approaches to optimizing the performance of thin-film photovoltaics by tuning the random potential through e. g. grain size, device thickness, etc.

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