Electrochemically Mediated Charge Transfer to Solids in Air

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***Abstract*— The conductivity, conductivity type, luminescence, and other properties of some insulators and semiconductors are a sensitive function of small concentrations of O2, NO2, NH3, SO2, and O3 in air. The cause of this effect has not been well understood. We present evidence that these observations are consistent with charge transfer between the solid and the oxygen redox couple in an adsorbed water film. In brief, the redox couple can act as an external acceptor or donor to the underlying solid. The direction of charge transfer depends on the relative positions of the Fermi energy of the solid and the electron chemical potential (Fermi energy) of the redox couple. This electrochemically mediated charge transfer appears to be a general, but often unrecognized, phenomenon. The effect has been confirmed in diamond, semiconducting carbon nanotubes, graphene, ZnO and GaN, and is strongly suspected as the source of! the electron accumulation layers observed on the In(groupV) semiconductors. The effect has implications for particle charging and for semiconducting sensors exposed to the ambient, and possibly even for sliding friction.**