Electron- and photon-stimulated desorption of alkali atoms from lunar sample and a model mineral surface[1]

B. V. Yakshinskiy and T. E. Madey

Department of Physics and Astronomy, and Laboratory for Surface Modification

Rutgers, The State University of New Jersey

We report recent results on an investigation of source mechanisms for the origin of alkali atoms in the tenuous planetary atmospheres, with focus on non-thermal processes (photon stimulated desorption (PSD), electron stimulated desorption (ESD), and ion sputtering). Whereas alkaline earth oxides (MgO, CaO) are far more abundant in lunar samples than alkali oxides (Na_2O, K_2O), the atmosphere of the Moon contains easily measurable concentrations of Na and K, while Ca and Mg are undetected there; traces of Ca have recently been seen in the Moon's atmosphere (10^{-3} of Na). The experiments have included ESD, PSD and ion sputtering of alkali atoms from model mineral surface (amorphous SiO_2) and from a lunar basalt sample obtained from NASA. The comparison is made between ESD and PSD efficiency of monovalent alkalis (Na, K) and divalent alkaline earths (Ba, Ca).The ultrahigh vacuum measurement scheme for ESD and PSD of Na atoms includes a highly sensitive alkali metal detector based on surface ionization, and a time-of-flight technique. For PSD measurements, a mercury arc light source (filtered and chopped) is used. We find that bombardment of the alkali covered surfaces by ultraviolet photons or by low energy electrons (E>4 eV) causes desorption of "hot" alkali atoms. This results are consistent with the model developed to explain our previous measurements of sodium desorption from a silica surface [2] and from water ice [3]: electron- or photon-induced charge transfer from the substrate to the ionic adsorbate causes formation of a neutral alkali atom in a repulsive configuration, from which desorption occurs. The two-electron charge transfer to cause desorption of divalent alkaline eath ions is a less likely process.The data support the suggestion that PSD by UV solar photons is a dominant source process for alkalis in the tenuous lunar atmosphere .

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[2] BVY and TEM, Nature **400,** 642 (1999).

[3] BVY and TEM, J. Geophys. Res. 106, E12 (2001) 33303