

Helium Adsorption and Superfluidity on Lithium and Sodium

P. Taborek, E. Van Cleve, F. Huisman, and A. Velasco

Department of Physics and Astronomy, University of California, Irvine, CA, USA

The lighter alkali metals are of interest for helium surface phase transition studies because they are intermediate strength substrates. This means that they are stronger than cesium so they are completely wet by helium even at $T=0$, but weaker than conventional substrates such as gold or glass, so that no localized solid-like layers are expected to form. We have used in situ low temperature laser ablation to form substrates of lithium and sodium on the surfaces of a quartz crystal microbalance (QCM). Helium adsorption isotherms were measured in the temperature range $0.4K < T < 1.6K$. At temperatures above 1K, the coverage on both substrates is linear in the pressure up to approximately 1 monolayer. The binding energies we obtain for lithium and sodium are -13.7 K and -9.5K, respectively, which are in reasonable agreement with theoretical predictions. Standard models also predict that helium films less than 2 layers should be unstable on sodium, with a first order prewetting transition to a thick film, but our data show continuous growth at all temperatures. For $T > 1K$, superfluid onset is marked by the conventional features of a Kosterlitz-Thouless (KT) transition. At lower temperatures, however, the transition temperature becomes a nonlinear function of the coverage. We discuss the possibility that this behavior is due to an intersection of the KT transition with the 2D liquid-vapor transition.