Microscopic Surface Structure of Liquid Alkali Metals

P. Huber,[1] O.G. Shpyrko,[1] H. Tostmann,[2] P.S. Pershan,[1] B.M. Ocko,[3] M. Deutsch[4]

[1]*Harvard University, Canbridge, MA, U.S.A.*

[2]*University of Florida, Gainesville, FL, U.S.A.*

[3]*Brookhaven National Laboratory, Upton, NY, U.S.A.*

[4]*Bar-Ilan University, Ramat-Gan, Israel*

Introduction

The structure of the free surface of a liquid metal (LM) is fundamentally different from that of a dielectric liquid, due to the strong coupling between conduction electrons and ion cores. At the liquid-vapor interface of an LM, the Coulomb interaction between the free-electron Fermi gas and the classical gas of charged ions acts like an effective hard wall and forces the ions into ordered layers parallel to the surface. The existence of surface-induced layering in LM has been verified unambiguously by experiment for liquid Hg, Ga, and In. Layering is also present in liquid binary alloys, even though it may be suppressed by surface segregation or the formation of surface phases.

Results

We report preliminary x-ray scattering results of the microscopic structure of the surface of a liquid alkali metal. The bulk liquid structure factor of the eutectic $K_{67}Na_{33}$ alloy is characteristic of an ideal mixture and so shares the properties of an elemental liquid alkali metal. A previous study (National Synchrotron Light Source, NSLS) of the specular x-ray reflectivity showed that the surface roughness of the K-Na alloy follows simple capillary wave behavior with a surface structure factor indicative of surface-induced layering. Comparison of the low-angle tail of the $K_{67}Na_{33}$ surface structure factor with the one measured previously for liquid Ga and In suggests that layering is less pronounced in alkali metals. The NSLS measurements used a rectangular-shaped resolution function, whereas those at the Advanced Photon Source (APS) used a nearly symmetrical resolution function. This allows us to take data to higher q, where h, a measure of the transverse lineshape, is appreciably larger. Although the APS results are preliminary, they demonstrate that, with focusing optics and a flatter sample, reflectvitity measurements will be possible to higher q. This will allow for a better understanding of surface-induced layering from this alloy.

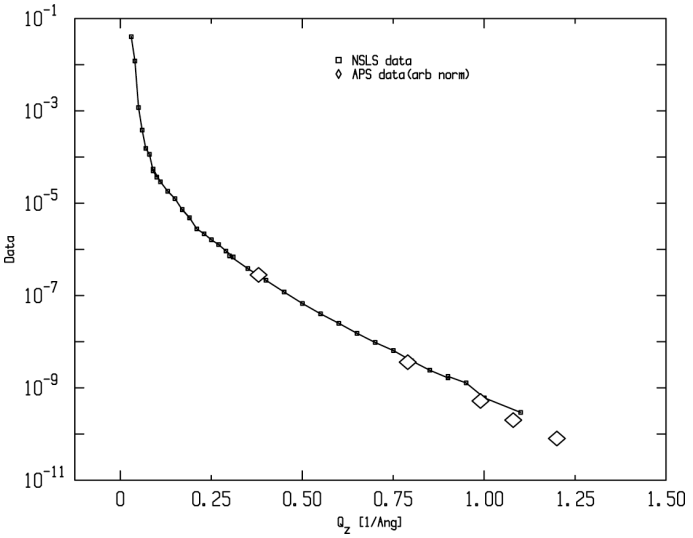

FIG. 1. X-ray reflectivity from a $K_{67}Na_{33}$ alloy. The data points shown as diamonds were acquired at the APS.

References

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