Expanded Fluid Metals

Friedrich Hensel
Institute of Physical-, Nuclear- and Macromolecular Chemistry
University of Marburg, Hans-Meerwein-Strabe, D-35032 Marburg

ABSTRACT

Fluid metals are typical examples of materials whose electronic structures depend strongly on the thermodynamic state of the system. The most striking manifestation of this state dependence is the metal-nonmetal transition which occurs when the dense liquid evaporates to the dilute vapour or when the fluid is expanded by heating to its liquid-vapour critical point. The lecture presents recent experimental results in the liquid-vapour critical region of metals which show that the existence of the metal-non-metal transition noticeably influences the electronic, thermodynamic, structural and interfacial features of the fluid. \(^1\);\(^2\);\(^3\);\(^4\)

The main emphasis is on inelastic neutron scattering experiments carried out on expanded liquid Rubidium. The shape of the dynamic structure factor \(S(Q,w)\) of liquid Rubidium changes considerably on approaching the metal-nonmetal transition region from the high-density metallic side, indicating a change in the interparticle interaction and the molecular structure. In the density range between the melting point density and three times the critical density the dynamic of the fluid is still controlled by collective excitations at high momentum transfer typical for dense metallic monatomic liquids. In expanding the liquid further to about twice the critical density, where a breakdown of metallic behaviour is expected, \(S(Q,w)\) changes its shape considerably. It is now characterized by an optic-type mode absorption, indicating that remnants of the diatomic unit present in the dense vapour phase of Rubidium may survive the condensation to the liquid. \(^5\)

Additional emphasis is on reflectivity experiments of fluid mercury against an optically transparent sapphire window close to the liquid vapour critical point (1478 Celsius, 1673 bar, 5.8 g/cm\(^3\)) which reveal clearly the existence of a prewetting transition of mercury on the sapphire substrate. The prewetting line intersects the coexistence curve at the wetting temperature of 1310 Celsius, and terminates at the prewetting critical temperature of 1468 Celsius and prewetting critical pressure of 1586 bar, a state lying close to the bulk critical point. Tw lies in the metal-nonmetal transition region. \(^6\)

References