

Melting Pressure of ^3He – ^4He Mixtures

J. Rysti, J. Tuoriniemi, A. Salmela, and A. Sebedash

Low Temperature Laboratory, Aalto University, Finland

At the lowest temperatures, the melting pressure of a helium mixture increases quadratically as a function of temperature. This is because the melting curve is essentially determined by the entropy of ^3He in the liquid phase. The solid phase can be assumed to be pure from ^3He . As temperature is raised, increasing amount of ^3He dissolves into the solid, whereby the melting pressure turns over and begins to decrease. The maximum pressure is obtained at approximately 300 mK. The melting pressure of dilute mixtures drops below that of pure ^4He at about 0.5 K and reaches a minimum around 1 K, beyond which a positive slope is observed again.

The melting pressure of pure ^3He is widely used as an empirical thermometric standard. In a similar manner, the melting pressure of helium mixtures can be used for thermometry. It gives superior resolution compared to ^3He at very low temperatures. Most importantly, the relation between pressure and temperature in dilute mixtures can be computed from theory.

We study the temperature and concentration dependencies of the melting pressure by using thermodynamic considerations and a previously determined effective interaction potential between ^3He quasiparticles in the liquid mixture.