RESISTIVITY OF LIQUID METALS

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Recently, liquid metals were widely investigated as a possible source of information on the interactions within their solid counterparts.

The Ziman theory of transport properties for liquid metals is very succesful if the interference function and the details of electron-ion interaction are known. This theory is based on the Born approximation for electron scattering. In the liquid state all scattering is supported to be confined to a spherical Fermi-energy shell. The interference function, which also determines liquid metal resistivity, is taken from x-ray and neutron diffraction experiments.

According to the Ziman theory we get the expression for the electrical resistivity:

$$\rho = \frac{3\pi m \Omega_0}{8\hbar e^2 E_F} \cdot \frac{1}{k_F^4} \int_0^{2k_F} |\langle \vec{k}+\vec{z}|w|\vec{k}\rangle|^2 a(z) z^3 \cdot dz \qquad (1)$$

where Ω_0 is the atomic volume, m is the effective electron mass, $\langle \vec{k}+\vec{z}|w|\vec{k}\rangle$ is the matrics element of the screened electron-ion potential for Fermi-surface scattering from single ions and a(q) is the structure factor of the liquid.

Different forms of local or nonlocal potentials, experimental and theoretical structure factors and variety of dielectrics functions have been used for the electrical resistivity calculations based on the expression (1) (see for instance /2-5/ and the literature cited there). Such difference between constituent elements influences on great dispersion of calculated resistivities.

Here we present the results of the resistivity calculations most of the simple liquid metals at the melting point. In these calculations the general model pseudopotential (GMP) /6/, theoretical structure factors obtained from Percus-Yevick equation fot packing density of 45%, and Hartree dielectric function included in GMP, are used. The packing density of 45%

gives the best fit for the experimental structure factors.

The GMP has the following form:

$$\langle \vec{k}+\vec{q}|W|\vec{k}\rangle = \alpha_1(Z-Z_0)\cdot \frac{\sin\left[2\pi\alpha_2(Z-Z_0)\cdot 2kk_F\right]}{2\pi\cdot 2/2k_F} \qquad (2)$$

where Z is the atomic number, Z_0 is the atomic number of the inert element that begins the period which includes the given Z. Model parameters α_1 and α_2 are given in /6/. The potential (2) is a function only of the atomic number and momentum transfer q, and it has no free parameters.

The results obtained by means of (1), GMP (2) and theoretical structure factors are given in fig. 1. Our theoretical results have the same behavior as the experimental results. This is not the case in some other calculations based on well known potentials (dashed curve on fig. 1, for instance).

The difference between experimental and our calculated resistivities varies but the trend of the change is the same. The exception is the period which contains Al. We also calculated the resistivities with the different dielectric functions. There are variations of up to 30% between the values obtained in that manner.

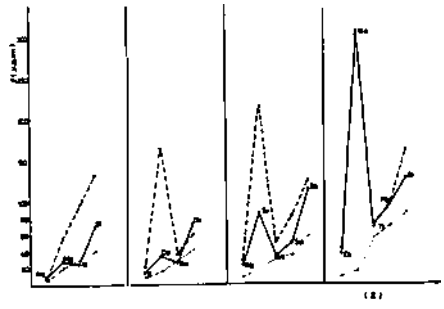

Fig. 1 Resistivities of simple liquid metals as a function of atomic number Z.

—— experimental results

- - theoretical results obtained by means of GMP

••• theoretical results obtained by means of the Heine-Animalu potential /2/.

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