Thermophysical Property Measurements of Pd Melt Using EML with a Static Magnetic Field

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In our previous research, we found that the Pd-X (X: Fe, Ni, and Cu) systems have order-disorder transitions in a solid solution range and have positive excess volume and negative excess Gibbs energy in a liquid state [1,2]. The excess volume decreases and the excess Gibbs energy increases as the number of electrons increases in the 3d orbital of X of the Pd-X melts. We considered that the correlation between the excess volume and Gibbs energy of the Pd-X melts was attributable to a change of the outermost orbital of Pd owing to mixing of Pd with X. A discussion of the correlation based on the electronic structure requires knowledge of the normal spectral emissivity, thermal conductivity, and density of state (DOS) of electrons in the Pd-X melts. However, even for a pure Pd melt, the thermophysical properties have not been established. For example, the literature values of thermal conductivity for Pd melts have a scatter of 14 % [3-5]. Assael et al. [6] pointed out that a large error is caused by circulation flow in the temperature wave method. Thus, the thermal conductivity of Pd melt should be reevaluated without an effect of flow. Our group has been developing an apparatus for thermophysical property measurements of metallic melts, namely, PROSPECT, which consists of an electromagnetic levitator (EML), superconducting magnet and laser modulation calorimetry system. In this study, emissivity, heat capacity, and thermal conductivity values of Pd melt were measured using PROSPECT. In addition, the correlation between the DOS of electrons and thermal diffusivities for transition metals in a liquid state are discussed based on the Mott model for s-d scattering.

References

[1] M. Watanabe, M. Adachi, H. Fukuyama, Correlation between excess volume and thermodynamics functions of liquid Pd-X(X=Fe, Cu and Ni) binary systems, The journal of chemical thermodynamics, 130(2019)9-16.

[2] M. Watanabe, M. Adachi, M. Uchikoshi, H. Fukuyama, Densities of Pt-X (X: Fe, Co, Ni and Cu) binary melts and thermodynamic correlations, Fluid phase equilibria, 515(2020) 112596. DOI: 10.1016/j.fluid.2020.112596.

[3] C. Cagran, G. Pottlacher, Thermophysical properties of palladium, Platinum metals review, 50(2006)144-149.

[4] B. V. Vlasov, S. G. Taluts, V. E. Zinov'yev, N. A. Korenovskii, V. P. Polyakova, Kinetic properties of iridium, rhodium, palladium and platinum in solid and liquid states, The physics of metals and metallography, 74(1992)371-377.

[5] K. C. Mills, B. J. Monaghan, B. J. Keene, Thermal conductivities of molten metals: part 1 pure metals, International materials reviews, 41(1996)209-242.

[6] M. J. Assael, A. Chatzimichailidis, K. D. Antoniadis, W. A. Wakeham, M. L. Huber, H. Fukuyama, Reference correlations for the thermal conductivity of liquid copper, gallium, indium, iron, lead, nickel and tin, High temperatures-high pressures, 46(2017)391-416.