Thermodiffusion in liquid alloys measured by X-radiography

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Thermodiffusion (or Soret effect) describes the formation of a concentration gradient induced by a temperature gradient in binary or multicomponent mixtures. This cross-coupling effect of heat and mass transfer influences the homogeneity of doped semiconductors and grown crystals as well as the microstructure formation in alloys. The calculation of thermodiffusion by molecular dynamic simulation can be very sensitive to the specific potential[1]. Recently improved theories were proposed but the database to validate models for thermodiffusion in liquid alloys is scarce.

For several organic mixtures the Soret coefficients have been measured with high accuracy[2]. However, for liquid alloys only very few Soret coefficients are known due to experimental challenges at the required high temperatures. We use X-radiography in combination with a high temperature furnace for space- and time-resolved measurements of the concentration distribution in the sample[3]. This offers increased process control and makes the simultaneous measurement of interdiffusion possible.

We present measurements of the Soret coefficient in aluminium-rich Al-Ag alloys at different concentrations. This alloy was chosen because of the high contrast between the two components in the X-ray spectrum used and because interdiffusion coefficients are known from independent measurements. The obtained interdiffusion coefficient are compared to literature values on the same system which corroborates the measured Soret coefficients. Silver is observed to migrate to the cold side.

References

[1] E. V. Levchenko, A. V. Evteev, T. Ahmed, A. Kromik, R. Kozubski, I. V. Belova, Z.-K. Liu, G. E. Murch (2016) Philos. Mag. 96, 3054.
[2]J.K. Platten, M.M. Bou-Ali, P. Costesèque, J. F. Dutrieux, W. Köhler, C. Leppla, S. Wiegand and G. Wittko (2003) Philos. Mag., 83, 1965.
[3] E. Sondermann, F. Kargl, and A. Meyer (2019) Phys. Rev. Lett., 123, 255902.

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