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Chemical diffusion in liquid metallic alloys

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Mechanisms of diffusion are well understood in solids with a large database of diffusion coefficients available. For liquids the situation is less clear. An experimental database with accurate diffusion coefficients even for comparatively simple binary systems is currently not available. Hence, it is difficult to test existing theories, models, or data obtained by numerical modelling against experimental data. The reason for the absence of experimental data has a number of origins: i) Many metallic liquids are highly reactive and show a comparatively high melting point. ii) Capillary experiments used to determine chemical diffusion coefficients can be affected by convective flow in the liquid and segregation and sedimentation as well as microstructure formation during heating and cooling, respectively. As a results diffusion coefficients can easily vary by a factor of 2 to 4.
Real-time monitoring of the capillary sample during diffusion overcomes part of the problems. The diffusion couple is monitored in real-time by using radiographic methods. The recorded grey values can be converted into sample concentration. Using X-ray radiography it was shown recently that accurate diffusion coefficients can be obtained for a binary alloy [1]. Here, we discuss results of recent experiments determining diffusion coefficients in-situ making use of neutron radiography [2]. For the discussed material combination neutron radiography compared with X-ray radiography offered sufficient contrast. Future requirements for neutron radiography to study self- and chemical-diffusion in liquids are discussed.

[1] B. Zhang, A. Griesche, A. Meyer Phys. Rev. Lett. 104, (2010) 035902.
[2] F. Kargl et al. J. Phys.: Cond. Matter 23, (2011) 254201.

Primary author: Dr KARGL, Florian (Deutsches Zentrum für Luft- und Raumfahrt (DLR))

Presenter: Dr KARGL, Florian (Deutsches Zentrum für Luft- und Raumfahrt (DLR))

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