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Diffusion in Glassy and Quasicrystalline Metallic Alloys

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This talk reminds the reader at first to some basic facts about glassy and quasicrystalline states [1]. Glassy metals, also called metallic glasses, comprise conventional and bulk metallic glasses and are usually produced by vitrification of undercooled melts. Quasicrystalline alloys are ordered but with icosahedral, decagonal and dodecagonal rotational symmetries, which are not compatible with rotational symmetries of classical crystallography. Quasicrystalline alloys usually occur as equilibrium phases in some multicomponent alloys. In some cases quasicrystalline single-crystals could be grown.
Our current understanding of diffusion in glassy metals and quasicrystalline alloys is reviewed by comparing the temperature dependence of diffusion -- its common features and its differences -- to that of corresponding crystalline metals. We mention available studies of the pressure dependence and the isotope effect and we discuss tracer diffusion and viscosity diffusion for a bulk metallic glass and its undercooled melt. Computer simulations of atomic jump processes indicate that the diffusion mechanism in metallic glasses differs from that in crystalline metals and involves thermally activated, highly collective (chain-like or caterpillar-like) diffusion jumps. We also remind the audience to positron annihilation studies, which – in addition to diffusion studies -- indicate that diffusion in quasicrystalline alloys is vacancy-mediated.

[1] H. Mehrer, Diffusion in Solids – Fundamentals, Materials, Diffusion-controlled Phenormena, Springer Series in Solid State Science 155, Springer Verlag, Berlin Heidelberg, (2010); see especially Chapter 21.