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Competition in phase formation during crystallisation of Al-Ni-Y metallic glasses

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Metallic glasses have attracted substantial attention in recent years due to their favourable combinations of high strength and corrosion resistance relative to conventional crystalline alloys. These properties make glassy metals appealing for applications such as surgical tools, electronics and sporting goods. However, glassy metals are metastable and crystallisation occurs when they are subjected to elevated temperatures or sustained deformation. While crystallisation is often considered detrimental to the properties, in some cases, controlled crystallisation can produce novel microstructures with unusual and desirable combinations of properties. The effect of crystallisation depends on which phases form, and the order of their appearance.

Of the Al-based metallic glasses, the ternary Al-Ni-Y system is among the most well studied. However, the sequence of phases that form during crystallisation remains unclear. In this investigation the crystallisation pathways in four Al-Ni-Y alloys with Ni concentrations ranging from 9 to 15 at.% have been studied in detail by in situ synchrotron powder diffraction. These experiments reveal that at low Ni concentrations crystallisation occurs via a two stage process, with α -Al forming as the first decomposition product, while at high concentrations crystallisation occurs via a three stage process, with the metastable $\text{Al}_{90}\text{Ni}_{10}$ phase forming first. The level of detail afforded by this approach allows us to better understand the competition in phase formation during crystallisation of metallic glasses and to use this information in the design of thermal treatments and compositions to optimize their potential usefulness.

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