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Rapid Solidification from Undercooled Melt of Fe-Rare Earth Magnetostriction Alloys

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Abstract

$Fe_{67}(Nd_{33-x}Dy_x)$, $Fe_{67}(Nd_{33-x}Tb_x)$ (x = 0, 16.5, and 33) droplets were containerlessly solidified using a 26 m drop tube. This was a challenge to produce the Laves phase directly from the undercooled liquid, which have been theoretically predicted to exhibit the high magnetostrictive strain. In the $Fe_{67}Nd_{33}$ sample, the Nd_2Fe_{17} and intergranular Nd phases were formed regardless of the sample diameter. On the other hand, in the $Fe_{67}Dy_{33}$ and $Fe_{67}Tb_{33}$ samples, the Laves phase was directly formed from the melt during its free fall. The amount of the Laves phase increased as the sample diameter decreased. As a result, the $Fe_{67}Dy_{33}$ sample with a diameter of 430 μm only consisted of the Laves phase. The $Fe_{67}(Nd_{16.5}Dy_{16.5})$ and $Fe_{67}(Nd_{16.5}Tb_{16.5})$ samples contained the Laves phase that was formed via a peritectic reaction between the Fe_3RE and liquid phases. The Fe_3RE phase was also directly formed from the undercooled melt, when the sample diameter was below 800 μm.