

Fe-Mg-Nd (Iron-Magnesium-Neodymium)

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Recently, [2005Tak] studied the feasibility of Nd extraction from B-Fe-Nd magnet scrap, using molten Mg as the extraction medium. During this study, they determined an isothermal section for the Fe-Mg-Nd system at 803 °C.

Binary Systems

The Fe-Mg phase diagram reviewed by [1993Nay] shows that there are no intermediate phases in this system and that the mutual solid solubility between Fe and Mg is very limited. The Fe-Nd phase diagram [1997Oka] depicts two intermediate compounds: $\text{Fe}_{17}\text{Nd}_2$ ($\text{Th}_2\text{Zn}_{17}$ -type rhombohedral) and $\text{Fe}_{17}\text{Nd}_5$ (hexagonal). The Mg-Nd phase diagram [1990Del] has four intermediate phases: $\text{Mg}_{41}\text{Nd}_5$ ($\text{Mg}_{41}\text{Ce}_5$ -type tetragonal), Mg_3Nd ($D0_3$, BiF_3 -type cubic), Mg_2Nd ($C15$, MgCu_2 -type cubic), and MgNd ($B2$, CsCl -type cubic).

Ternary Isothermal Section

With starting metals of 99.95% Mg, 99.7% Nd, and an Fe-Nd alloy, [2005Tak] melted 13 Fe-poor compositions under Ar atmosphere. The samples were annealed at 803 °C

(1076 K) for 24 h and quenched in water. The phase equilibria were studied by x-ray powder diffraction and energy dispersive x-ray spectroscopy. The isothermal section at 803 °C constructed by [2005Tak] is redrawn in Fig. 1 to agree with the accepted binary data. No ternary compounds were found in the system. $\text{Fe}_{17}\text{Nd}_5$ and the Mg-Nd compounds are not stable at this temperature. [2005Tak] concluded that extraction of Nd from the B-Fe-Nd magnet scrap is feasible, as Mg-Nd liquid with 24 at.% Nd exists in three-phase equilibrium with $\text{Fe}_{17}\text{Nd}_2$ and solid Fe.

References

- 1990Del:** S. Delfino, A. Saccone, and R. Ferro, Phase Relationships in the Neodymium-Magnesium Alloy System, *Metall. Trans. A*, 1990, **21A**, p 2109-2114
- 1993Nay:** A.A. Nayeb-Hashemi, J.B. Clark, and L.J. Swartzendruber, Fe-Mg (Iron-Magnesium), *Phase Diagrams of Binary Iron Alloys*, H. Okamoto, Ed., ASM International, 1993, p 200-202
- 1997Oka:** H. Okamoto, Fe-Nd (Iron-Neodymium), *J. Phase Equilib.*, 1997, **18**(1), p 106
- 2005Tak:** O. Takeda, T.H. Okabe, and Y. Umetsu, Phase Equilibria in the System Fe-Mg-Nd at 1076 K, *J. Alloys Compd.*, 2005, **392**, p 206-213

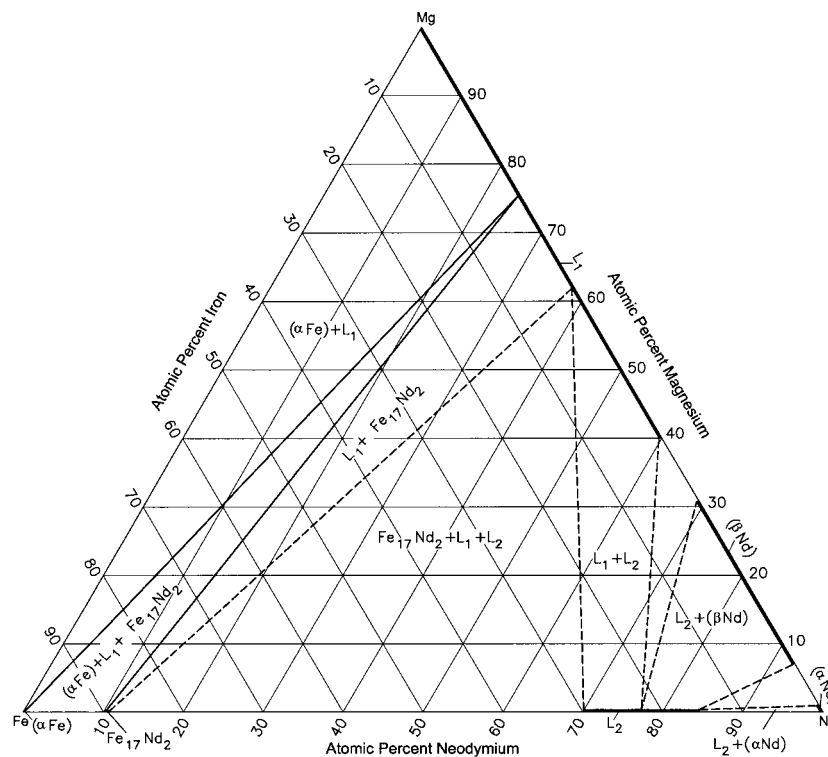


Fig. 1 Fe-Mg-Nd isothermal section at 803 °C [2005Tak]