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Phase equilibrium diagram of Co-Fe-Pd

Abstract

There is potential to use Co-Fe-Pd rare earth-doped alloys for magnets. The system offers possible alternatives for the heavy and expensive rare-earth magnets. The phase diagram of Co-Fe-Pd was derived nearly sixty years ago and is inconsistent. Therefore, the system needs to be studied again to provide an accurate and updated phase diagram to facilitate the development of the potential magnetic alloys.

Samples of different compositions of Co-Fe-Pd were made in a button arc furnace, under an argon atmosphere on a water-cooled copper hearth. They were sectioned and part was kept in the as-cast state and the other part annealed. The samples were analysed in a scanning electron microscope with energy dispersive X-ray spectroscopy to observe the microstructures and to determine the overall and phase compositions. Samples were also analysed in an X-ray diffractometer to confirm the phases. The same analysis procedure was followed for the as-cast and the annealed samples.

Coring occurred in many samples, which was expected due to the wide solid solutions in the system. The microstructures were not similar to any of the previous work. There was better agreement of the as-cast samples with the assessed 25°C isothermal section of Raghavan [1992Rag], than with the experimental one of Kuprina and Grigorev [1961Kup]. The deduced liquidus slope agreed with both of the liquidus surfaces published.

Some of the phases were too fine to be analysed in the as-cast samples. It was expected that annealing the samples would have coarsened the grains, but the phases were still to fine to analyse. The 1000°C alloys were not homogenous and apart from three alloys which had two phases, the others comprised only one phase. The FePd and $FePd_3$ regions of the Fe-Pd binary diagram did not extend perceptibly into the ternary system. The 1000°C isothermal section was comprised mainly of the (γFe, αCo, Pd) phase.

The samples were also annealed at 650°C. The ordered α' peaks were difficult to identify by XRD, and FePd and $FePd_3$ were difficult to distinguish from (γFe, αCo, Pd). There was a (γFe, αCo, Pd) miscibility

gap in the system, around Co_{71}:Fe_{16}:Pd_{13} – Co_{31}:Fe_{22}:Pd_{47}. The hardness of the alloys increased with increased Fe and decreased Pd contents. The three conditions followed the same trends for hardnesses.