STUDY OF THE CRYSTALLIZATION KINETICS IN AMORPHOUS Fe$_{83}$P$_{17}$ ALLOY

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The crystallization kinetics of Fe$_{83}$P$_{17}$ amorphous alloy has been studied by Mössbauer spectroscopy and X-ray diffractometry. The samples were annealed isothermally at two different temperatures (315 °C and 325 °C). During isothermal annealing of the samples three phases were observed: crystalline Fe$_3$P phase, crystalline α-Fe phase and the amorphous phase. The value of the Avrami exponent was found to be about 2.0 at each annealing temperature. This suggests that the growth rate of the crystals is controlled by volume diffusion and the nucleation rate decreases during crystallization. The activation energy obtained for the overall crystallization process was 193 ± 43 kJ mol$^{-1}$.

INTRODUCTION

A glass is defined as any solid formed by the continuous cooling of a liquid such that detectable crystallization is avoided. Since the amorphous state is meta-

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ble, it possibly transforms into a more stable crystalline state. The ease of the devitrification varies widely between different glassy systems. Metallic glasses generally transform so rapidly that it is rarely possible to heat them much above 0.5 \( T_m \) before spontaneous crystallization occurs (\( T_m \) is the equilibrium melting point). The most promising properties of metallic glasses (e.g. the excellent magnetic behavior or the high hardness and corrosion resistance) have been found to deteriorate drastically during crystallization. On the other hand, controlled crystallization of metallic glasses can be used to produce special partially or fully crystallized microstructures unobtainable by other methods.

Crystallization has been observed to occur generally by nucleation and growth processes. Depending on concentration, transition of the amorphous phase into the crystalline phases can proceed by polymorphous, primary or eutectic reactions. The crystallization of most metallic glasses is complicated by decomposition reactions, i.e. primary or eutectic crystallization occurs. To describe the mechanism of such phase changes, there are several successful phenomenological theories. The theory most generally used for describing of solid state nucleation and growth transformations has been developed by Johnson, Mehl and Avrami (JMA).

The aim of the present work is to study the crystallization kinetics of the Fe\(_{83}\)P\(_{17}\) amorphous alloy by Mössbauer spectroscopy and X-ray diffractometry. For this reason isothermal annealing of the samples was carried out at two different temperatures.