 CONF-8604119--1

RADIATION-INDUCED SEGREGATION IN Cu-Au ALLOYS*

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DE86 005528

December 1985

Submitted to the 1986 Spring Meeting of the Japan Institute of Metals, April 2-4, 1986, Tokyo, Japan.
*Work supported by the U. S. Department of Energy, BES-Materials Sciences, under Contract W-31-109-Eng-38.

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INTRODUCTION

Net production rate of freely migrating defects that cause microstructural changes must be known before correlation of microstructural changes under different irradiation conditions can be made. The primary interests for reactor communities occur at elevated temperatures. Recently, relative efficiencies of different ions for producing freely migrating defects at 350-650°C were determined from measurements of Radiation-Induced Segregation (RIS) in Ni-Si alloys.[1] It was found that only a few per cent of defects become free to migrate in heavy ion irradiations at elevated temperatures. In order to test the universality of the results found for Ni-Si alloys, we determined the relative efficiencies using Cu-Au alloys. In this presentation, we report kinetics of RIS in Cu-Au alloys that provides the basis for efficiency determination.

PROCEDURE

RIS in Cu-lat.% Au alloys was investigated by in situ Rutherford Backscattering Spectrometry (RBS) using 1.8-MeV He ions. The amount of segregation, which is defined as the number of Au atoms per unit area transported out of near surface region, was measured as a function of dose, dose rate and temperature. Cross section of Frenkel pair production in the near surface region was computed using PINTO program[2] in order to calculate

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corresponding displacement rate from beam current density.

RESULTS

Irradiation produced Au atom depletion in the near surface region. Since the analysis of measurements of Au diffusion in Cu in terms of the five-frequency model predicts that vacancies preferentially transport Au atoms toward the surface,[3] interstitials are apparently responsible for the observed Au atom depletion. Segregation occurred in the temperature range between about 300 and 500°C. As shown in Fig. 1, it peaked near 400°C for a calculated dose rate of 3.9×10^{-5} dpa/s.

Theoretical analysis based on Johnson-Lam model[4] predicted (1) that the amount of segregation would be proportional to dose in the early stage of irradiation, would deviate from linearity with a continuously decreasing slope at intermediate doses, and finally approach a constant value after high doses; (2) that segregation rate would vary as −1/4th power of the dose rate at constant dose in the low temperature region. Figure 2 shows dose rate dependence of segregation. The ratio of segregation rate which was obtained by polynomial fitting agreed well with −4th root of dose rate ratio.

These understandings of segregation kinetics provide the basis for determining defect production efficiencies in Cu-Au alloys at elevated temperatures.

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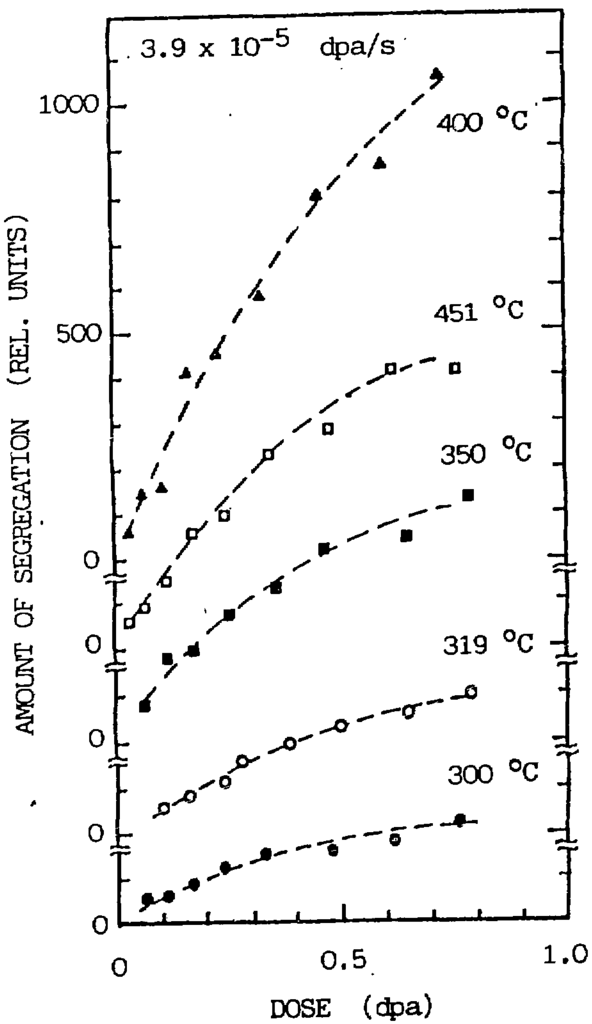

Fig. 1. Temperature and dose dependence of segregation.

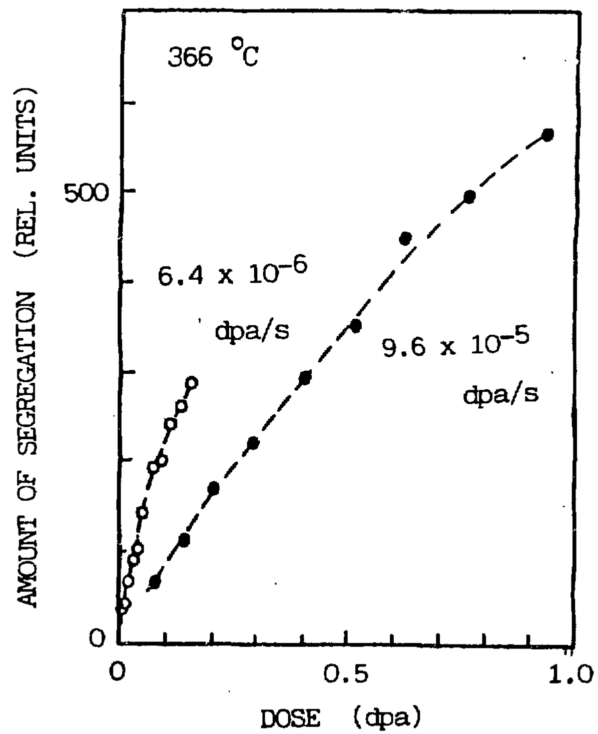

Fig. 2. Dose rate dependence of segregation.