Iron Diffusion in Alloy $Fe_{76}Mo_8B_{15}Cu_1$

Comparing with

<Self-Diffusion and Interdiffusion in Gold-Nickel Alloys>

- **Introduction**

Amorphous alloys : they show magnetic parameters(FINEMET or NANOPERM)

Alloys are not in thermodynamically stable state->D decreases with time due to the relaxation of free volume. D can be achieved after certain relaxation time(precedes crystallization).

Two types of diffusion mechanism :

① Direct : not mediated by any defect

② Indirect : mediated by quasi-vacancies

For $Fe_{76}Mo_{8}B_{15}Cu_{1}$: amorphous NANOPERM-type material

- **Experiments**

Sample : prepared by single roller melt-spinning technique

6 mm wide and 20 nm thick, annealed at 695K for 1.5 hrs

Radiotracer measurements : polished by (i) vacuum evaporation technique, (ii) direct dripping of radioisotope -> evaporated by thermal shock -> diffusion measurement at 527-649K

-Amount of crystallized phase checked by Mossbaur measurement

-penetration profiles were obtained by serial sectioning method

Concentration profiles : by DC-glow distance sputtering profile is composed of 4 segments as shown in Fig 1

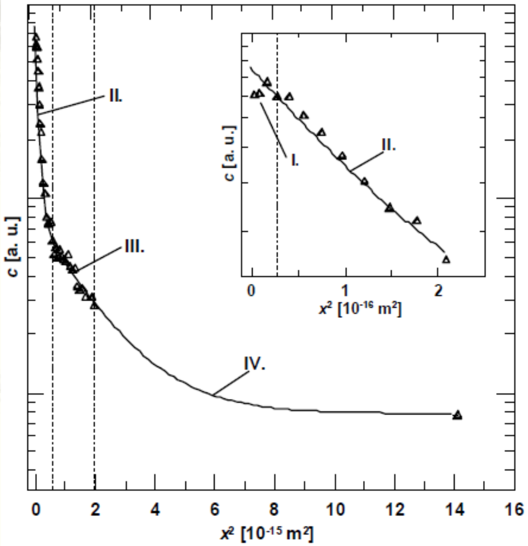

Fig. 1. An example of penetration profile $c(x,t)$ with characteristic segments (I.-IV.). Full line – Eq. (1), small picture – detail of beginning of the profile.

- # Results and Discussion

Diffusion of Fe

$$C(x,t) = A\exp\left(\frac{x^2}{4D_1t}\right) + B\exp\left(\frac{x^2}{4D_2t}\right) + C$$

D_1, D_2 can be obtained by this fitting parameters

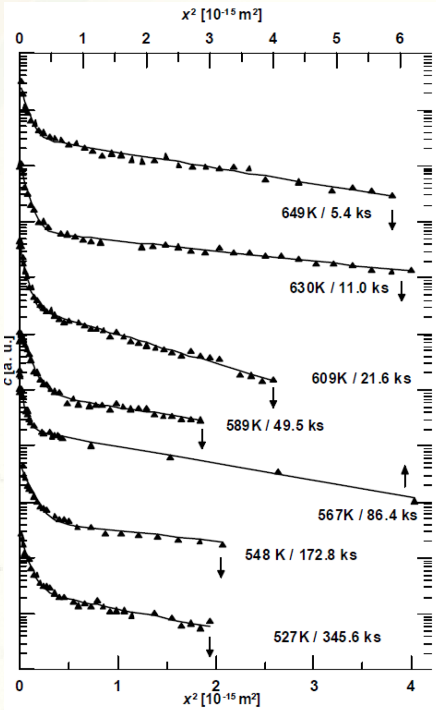

Fig. 2. Penetration profiles $c(x,t)$ for ^{59}Fe self-diffusion in experimental alloy relaxed at 695 K for 1 hour (vacuum evaporated).

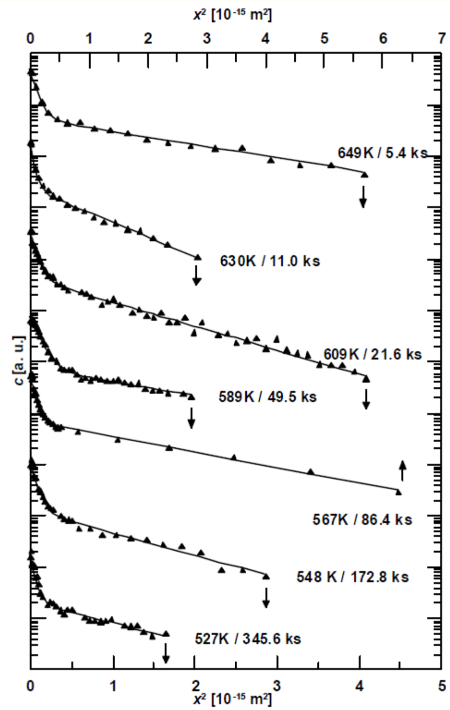

Fig. 3. Penetration profiles $c(x,t)$ for ^{59}Fe self-diffusion in experimental alloy relaxed at 695 K for 5 hours (vacuum evaporated).

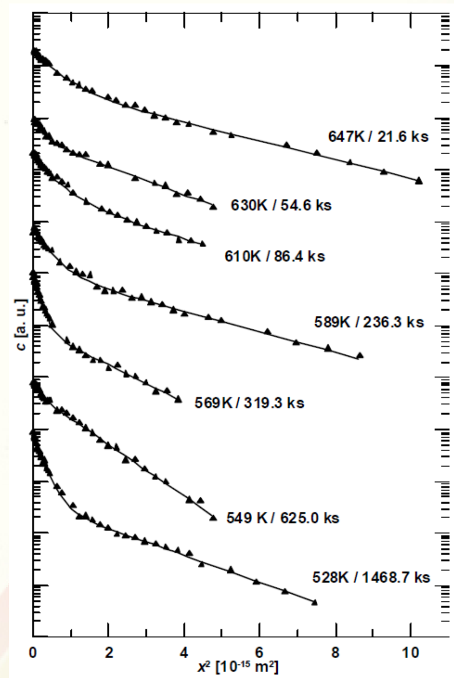

Fig. 4 Penetration profiles $c(x,t)$ for ^{59}Fe self-diffusion in experimental alloy relaxed at 695 K for 1 hour (dripped and dried).

Temperature dependence ; fig 5 (D_1: relaxed for 1 hr, D_2 : relaxed for 5 hrs)

D_1 characterize the diffusion in relaxed amorphous phase

D_2 smaller fraction of crystallized phase->lower D (effect of crystalline phase)

Ds are agree reasonably with the literature

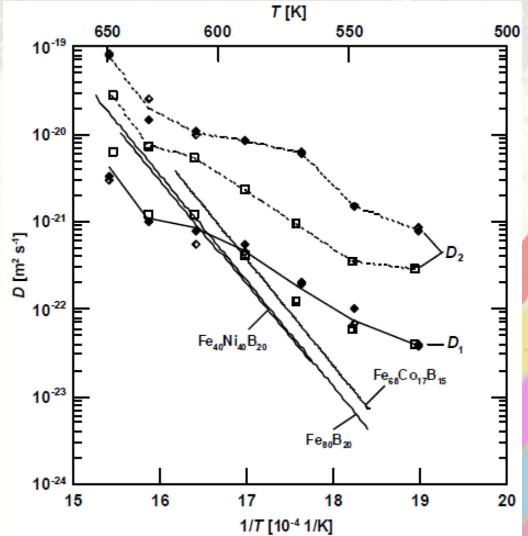

Fig. 6 Temperature dependence of *D* for Fe self-diffusion in experimental alloy (empty diamonds – tracer evaporated, full diamonds and empty squares – tracer dripped and dried) compared with data on Fe self-diffusion, in amorphous $Fe_{80}B_{20}$ [12], $Fe_{40}Ni_{40}B_{20}$ [13], and

Diffusion in amorphous alloy is realized by jumps with varied activation enthalphies -> Temperature dependence caused by the fact : whereas at higher T jumps with higher activation prevail, at lower T diffusion of Fe occurs prevailingly via jumps with lower activation H

- **Conclusion**

by penetration profiles : there are 2 diffusion mechanisms controlling Fe diffusion in relaxed amorphous alloy-slower and operates, presence of crystalline phase

temperature dependence : at highest T – D is close to literature values curvature may be caused by variation in activation H at higher T and at lower T