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ELECTRON RADIATION DAMAGE STRUCTURE IN BINARY COPPER ALLOYS

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In this work, the effect of 1 MeV electron irradiation on the initiation and development of segregation and point defect agglomeration structures in binary copper alloys has been studied in situ, with the aid of a high voltage electron microscope. The binary copper alloys had Be, Pt and Sn as alloying elements which had atomic radii less than, similar and greater than of copper, respectively. It has been observed that in a wide irradiation temperature range, stabilization and growth of dislocation loops took place in Cu-Sn and Cu-Pt alloys. Whereas in the Cu-Be alloy, radiation induced precipitates formed and transformed to the stable phase. It is very important the interaction between the lattice point defect and the second element of the alloy. In this case of strong trap the effect migrates with a effective migration energy and the bounding energy. If the migration energy of the complex is small enough, they can migrate as a entity. These complexes are very important in the radiation induced segregation on the Cü-Be alloys (1,2).

In Cu-Be alloys, with electron irradiation and increasing irradiation temperature was observed a sequence of metastable phases. Between 300K and 400K we observe the formation of Guinier-Preston zones (tweed texture contrast). In the 400K-500K temperature range forms a great amount of very small precipitates whose habit plane is [100]. The precipitation occurs in any part of the matrix. For $500K \leq T \leq 730K$, the precipitation can also occur at dislocation sites. The habit planes for the precipitates are [113] and [112]. With increasing of the precipitate diameter, during the irradiation, part of them lost their coherency partially or totally (Fig. 1). At observed highest irradiation temperatures (T~800K) do not occur more precipitation but starts void formation.

Relating the Cu-Sn and Cu-Pt alloys, the dislocation loops are Frank sessile loop with $b=(a/3)\langle 111\rangle$ or a glissile loop with $b=(a/2)\langle 110\rangle$. In the first irradiation temperature range predominates a small point defect agglomerate, a black point, with the diameter situated between 4 nm and 15 nm. In the second range we observed the typical dislocation loop that grows in size with increasing irradiation temperature (Figs. 2 and 3). The last observed temperature range, $680K \leq T \leq 800K$, predominates the formation of isolated dislocation.

Our results could be explained with the chemical kinetics theory (3) where the segregation results from the formation and migration of intertitial-solute complexes and goes through a maximum when the migration energy of the complex becomes nearly equal to the vacancy migration energy. Thus especially strong solute enrichment via

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complexes is expected for solutes that trap interstitial atoms at least up to temperatures where vacancies become mobile. This segregation mechanism is expected to be important for undersize solutes since both experimental and theoretical studies indicate that undersize solutes trap interstitial atoms much more strongly than oversize solutes.

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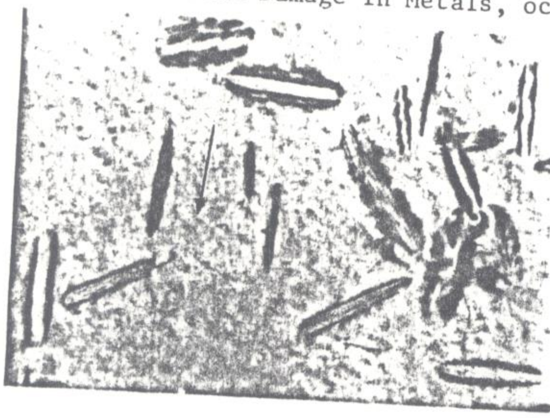

Fig.1:Microstructure of irradiated Cu-7at%Be, T=688K, k=5.3x10^{-4} dpa/s, dosis=25x10^{-2} dpa B=[011], g(111); mag.: 63,000x.

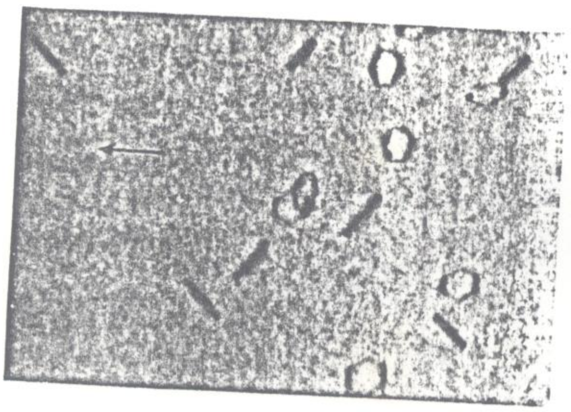

Fig.2:Microstructure of irradiated Cu-1at%Sn,T=628K, k=14x10^{-4} dpa/s, dosis=25x10^{-2} dpa, B= [001], g(200); mag.: 72,000x.

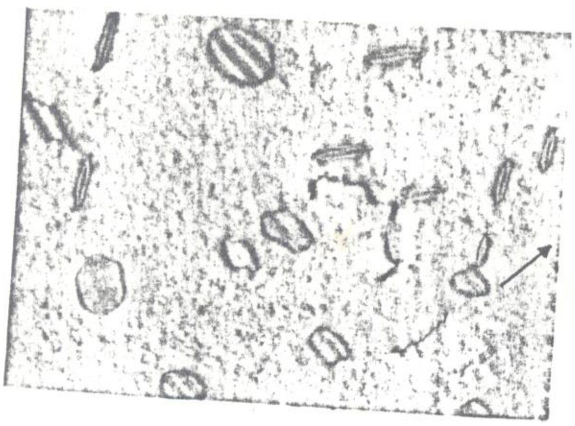

Fig.3:Microstructure of irradiated Cu-1at%Pt, T= 655K, k=4,6x10-4 dpa/s, dosis=20x10^{-2} dpa, B=[011], g(200); mag.: 63,000x.