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DETERMINATION OF STRUCTURAL ELEMENTS SIZE OF THE FINEMET-TYPE AMORPHOUS ALLOY

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Aim of The Work

This work is devoted to the metallographic determination of the crystallite sizes of the initially amorphous soft magnetic alloy $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$ in the nanocrystalline and recrystallized states and its comparison with the results of modeling based on the results of X-ray diffraction analysis.

Investigation object

FIG 1. Sample of amorphous tape of the $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$ alloy

The object of the study was industrial soft magnetic alloy $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$. The sample was amorphous precursor as a tape 20 μm thick and 10 mm wide prepared by melt spinning technique.

X-ray Diffraction

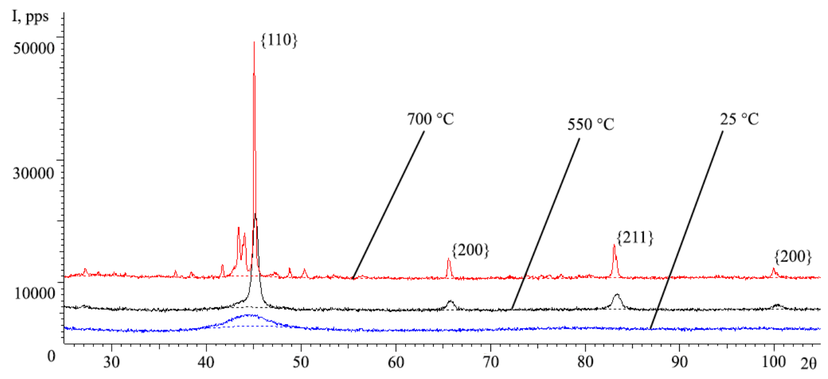
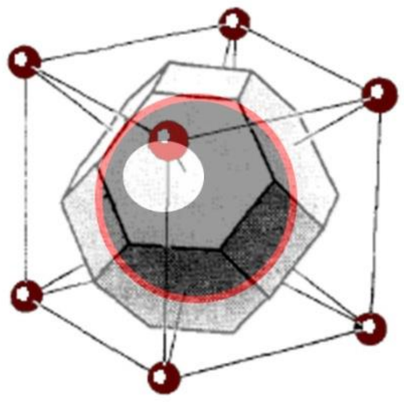


FIG 2. Diffraction patterns for three states of the alloy (amorphous, recrystallized, nanocrystalline) at different annealing temperatures: amorphous - 25 ° C; nanocrystalline - 550 ° C; recrystallized - 700 ° C.

This one was used for coherent scattered regions calculating

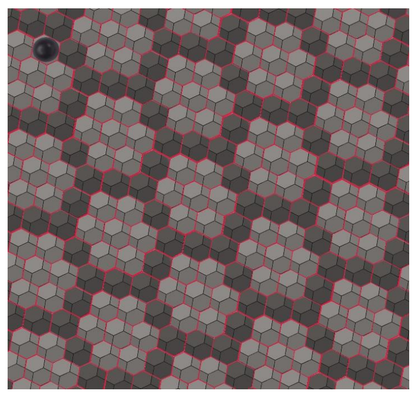
The structural units simulation

The Wigner-Seitz cell



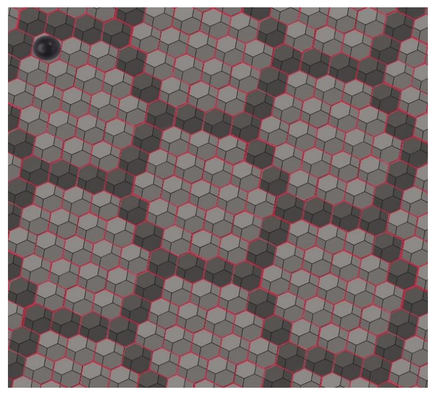
a

Before annealing



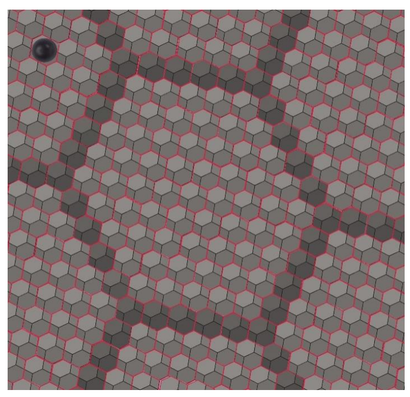
b

550 °C



c

700°C



d

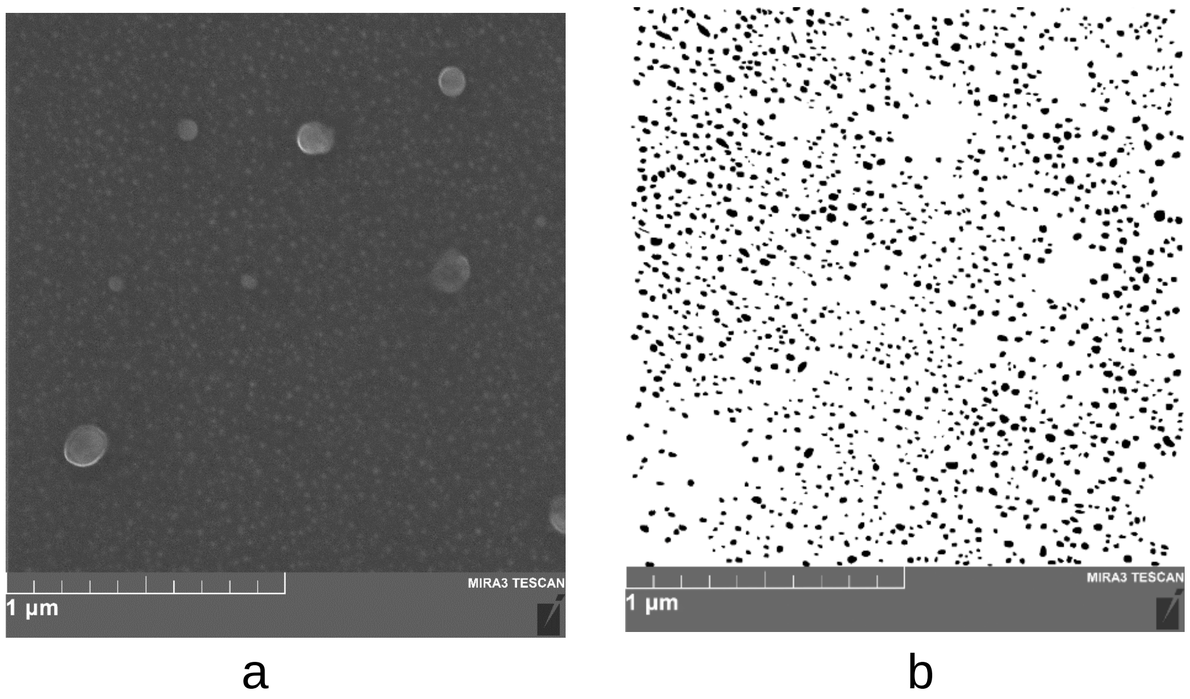
FIG 3. The structural units simulation: minimal structural unit (a) amorphous (b), nanocrystalline (c) and recrystallized (d) states.

The coherent scattering regions **(CRS) (L)** was calculated using bcc iron **{110} α** line by $L_x = K \cdot \lambda / (\beta \cdot \cos \theta)$, where **K** = const ≈ 0.9; **β** is the integral width of the diffraction line, expressed as radians; **cos (θ)** corresponds to the position of the center of gravity of the diffraction line

It was assumed that amorphous, nanocrystalline, and recrystallized states have different CSR sizes. The CSR size is several Wigner-Seitz cells along the one cluster length. This idea simulates nanocrystalline and recrystallized states, i.e., nanograins and grains.

Scanning electron microscopy

550 °C



a b

FIG 4. Microstructure of $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$ (SEM) after annealing at 550 ° C (a) and processed image for calculating by software (b).

700 °C

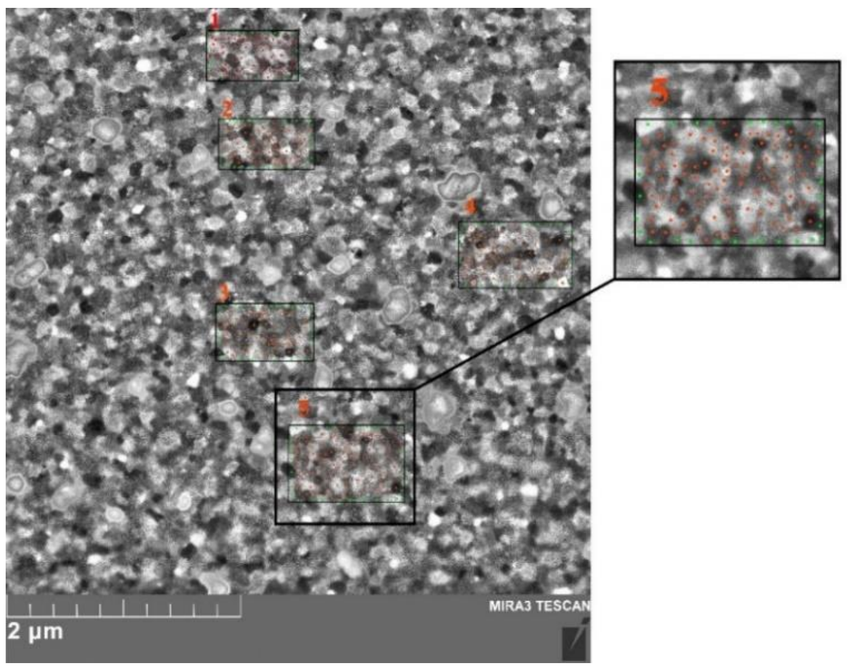


FIG 5. Microstructure of a ribbon of $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$ after annealing at 700 °C (SEM) with a demonstration of statistical metallographic analysis.

***t*, °C**	**CSR (*L*), nm**	***crystallite size*, nm**
20	2	Not defined
550	14	17
700	86	85

Table 1. Calculated CSR sizes and experimentally determined average crystallite sizes in the of $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$ alloy after different annealing temperatures.

SUMMARY: The results of calculating the sizes of crystallites obtained by statistical metallographic analysis of samples of the $Fe_{72.5}Cu_1Nb_2Mo_{1.5}Si_{14}B_9$ alloy after annealing at 550 and 700 ° C showed good agreement with the sizes of the coherent scattering regions calculated from the XRD data.