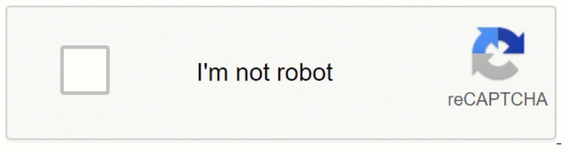

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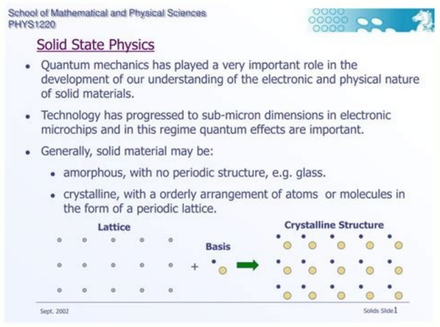

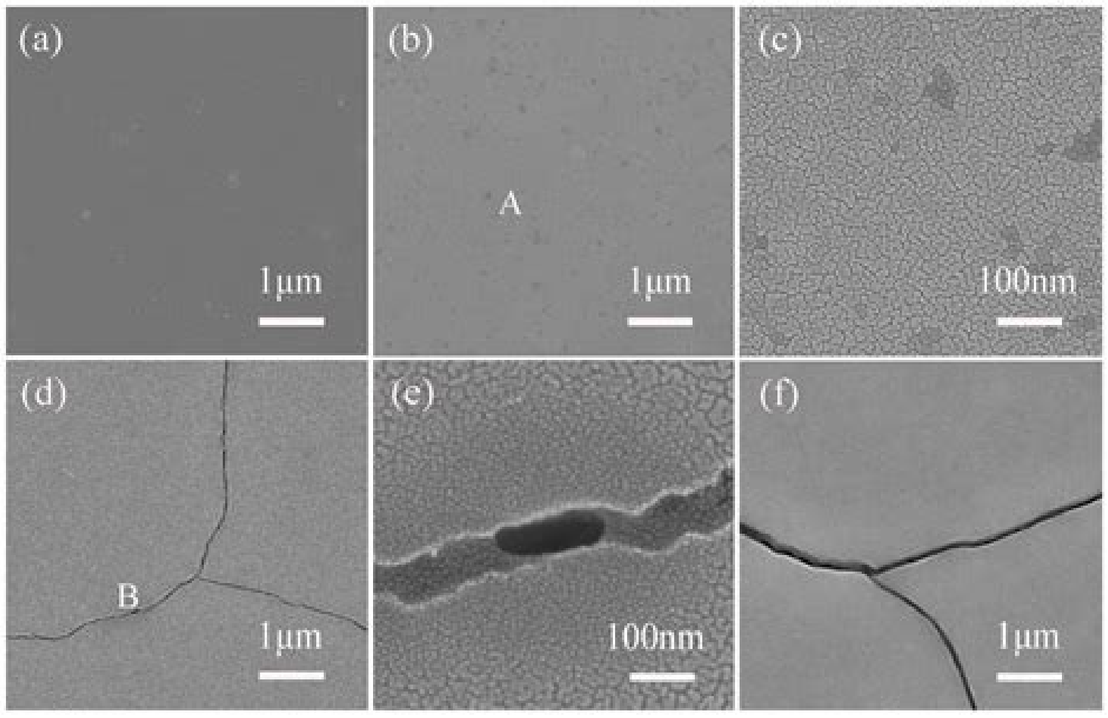

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THE INFLUENCE OF AN ISOTHERMAL ANNEALING PROCESS ON THE STRUCTURE AND MAGNETIC PROPERTIES OF THE BULK AMORPHOUS ALLOY FeCoBYMo

VPLIV IZOTERMNEGA ŽARJENJA NA STRUKTURO IN MAGNETNE LASTNOSTI MASIVNE AMORFNE ZLITINE FeCoBYMo

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This paper presents the results of research into a bulk amorphous alloy based on Fe. Samples with the composition $Fe_{61}Co_{10}Y_8Mo_4B_{15}$ were prepared in the form of plates using an injection-casting method. The samples were then subjected to an isothermal annealing process (at less than the crystallization temperature) of 700 K for 1 h and 770 K for 3.5 h The structures of the samples were investigated, both in the state after solidification and following the heat treatment, using X-ray diffraction (XRD) and Mössbauer spectroscopy. The results confirmed that the samples, both after solidification and after annealing, were amorphous. Magnetic measurements were carried out using a vibrating-sample magnetometer (VSM) with magnetic fields of up to 2 T. Based on these measurements, the effect of the isothermal annealing process on the magnetic properties was defined, including the saturation magnetization $\mu_0 M_s$ and coercive field H_c. Using the Kronmüller theory, the initial magnetization curves were analysed in the area of approach to ferromagnetic saturation. On the basis of this theory, the quantity and quality of the structural defects were defined; these defects play a critical role in the magnetization process in high magnetic fields. Following this study, the sample annealed at 770 K for 1 h was found to feature a relatively low coercive field and the higher value of magnetization saturation. Linear defects, the so-called quasidislocational dipoles, played the leading role in the process of magnetization of the test samples.

Keywords: bulk amorphous alloys, structure, soft magnetic properties, defects

Članek predstavlja rezultate raziskave masivne amorfne zlitine na osnovi Fe. Vzorci s sestavo $Fe_{61}Co_{10}Y_8Mo_4B_{15}$ so bili pripravljeni v obliki plošč, s pomočjo tlačnega litja. Vzorci so bili izotermno žarjeni 1 h (pri temperaturi nižji od temperature kristalizacije) na 700 K in 3,5 h na 770 K. Preiskana je bila struktura vzorcev, v stanju po strjevanju in po toplotni obdelavi. Uporabljena je bila rentgenska difrakcija (XRD) in Mössbauerjeva spektroskopija. Rezultati so potrdili, da so bili vzorci po strjevanju in po žarjenju v amorfnem stanju. Magnetne meritve so bile izvedene s pomočjo magnetometra z vibriranjem vzorca (VSM) v magnetnih poljih jakosti do 2 T. Na osnovi meritev je bil določen vpliv izotermnega žarjenja na magnetne lastnosti, vključno z nasičeno magnetizacijo $\mu_0 M_s$ in koercitivnim poljem H_c. Z uporabo Kronmüllerjeve teorije so bile analizirane začetne krivulje magnetizacije bližu področja feromagnetnega nasičenja. Na osnovi te teorije je bila določena količina in kakovost strukturnih napak; te napake igrajo ključno vlogo pri procesu magnetizacije v močnih magnetnih poljih. Na podlagi te študije je bilo ugotovljeno, da vzorci žarjeni 1 h kažejo relativno šibko koercitivno polje in visoko vrednost nasičene magnetizacije. Linearne napake, imenovane kvazi-dislokacijski dipoli, igrajo vodilno vlogo pri procesu magnetizacije preizkušanih vzorcev.

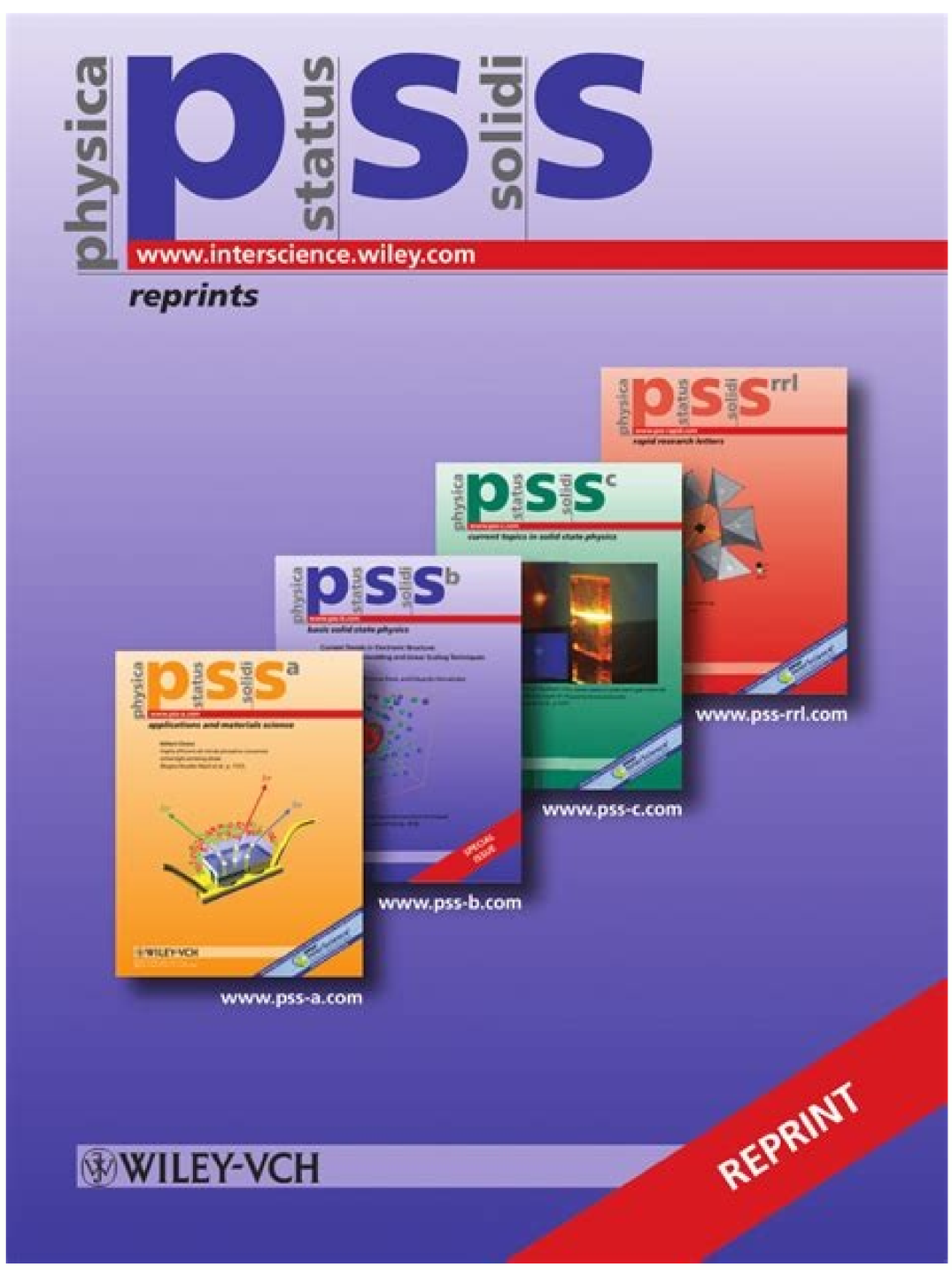
Ključne besede: masivne amorfne zlitine, struktura, mehko magnetne lastnosti, napake

1 INTRODUCTION

Amorphous soft magnetic materials are investigated in many research centres around the world. These materials are characterized by a low coercive field and high saturation magnetization.[1–3] From a thermodynamic point of view, the structure of these materials is metastable. Nevertheless, such materials can be applied in devices such as electronic measuring and surveillance systems, magnetic wires, magnetic sensors, band-pass filters, magnetic shielding, energy-saving electric power transformers and other applications.[4,5] During the past 20 years, intensive research has been conducted on amorphous alloy groups having a thickness or diameter exceeding 100 μm; these are called bulk metallic glasses (BMGs).[6,7] These materials have good soft magnetic properties and a high mechanical strength.[8]

As mentioned previously, rapidly cooled amorphous materials are thermodynamically unstable; they exhibit instability in their physical properties with respect to time and temperature. In general, their thermodynamic stability can be improved by annealing for a specified time at appropriate temperatures.[9–12]

As shown in the literature, the magnetic properties of amorphous alloys depend strongly on the annealing temperature.[13–16] During the earlier sample production process, free volumes are created; annealing the samples at low temperatures leads to the diffusion of these free volumes to the surface of the material. Thus, the soft magnetic properties of these alloys can be improved



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