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Program and materials

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16.30–16.50 TO-13
Alontseva Darya, East Kazakhstan State Technical University, Kazakhstan. The structural phase changes in Ni-based coatings deposited by plasma detonation and the results of coatings modification by duplex treatment

16.50–17.10 Coffee break

Session V Chairmen: A. Pogrebnyak, D. Milčius

17.10–17.40 TO-14 (Invited)
Gintautas Abrasonis, Forschungszentrum Dresden-Rossendorf, Dresden, Germany. PVD growth of carbon-transition metal nanocomposites: from energetic condensation to spin-dependent transport

17.40–18.00 TO-15
Liutauras Marcinauskas, Kaunas University of Technology, Lithuania, *A. Grigonis*. Formation of amorphous carbon structures at atmospheric pressure

18.00–18.20 TO-16
Andrzej Misiuk, Institute of Electron Technology, Warsaw, Poland, *C.A. Londos, W. Wierzchowski, J. Bak-Misiuk, P. Romanowski, K. Wieteska, E.N. Sgourou, M. Prujszczyk*. Oxygen-related defects in neutron irradiated n-containing Cz-Si annealed under enhanced pressure

18.20–19.30 P2 - Poster session, Chairman J. Puišo

P2-1. *A. Laurinavičius, A. Baltrušaitis, V. Pranckevičienė*. Investigation physical properties of wood using millimeter wave radiation

P2-2. *M. Gaspariūnas, A.V. Goncharov, V.V. Levenets, V. Kovalevskij, A. Plukis, R. Buzelis, S. Kyčas, V. Remeikis*. RBS analysis of multilayered optical coatings

P2-3. *R. Giriūnienė, P. Každailis, D. Čiplys, K. Šliužienė, B. Vengalis, V. Lisauskas*. Acoustoelectric interaction in thin lanthanum manganite films

P2-4. *J. Reklaitis, K. Mažeika, D. Baltrūnas, V. Remeikis*. Rayleigh scattering of Mössbauer radiation in polystyrene

P2-5. *J. Šapolaitė, G. Lujanienė, E. Radžiūtė*. Cs, Pu and Am interaction with the clay engineered barrier

OXYGEN-RELATED DEFECTS IN NEUTRON IRRADIATED N-CONTAINING Cz-Si ANNEALED UNDER ENHANCED PRESSURE

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Abstract

Creation and transformation of oxygen-related defects in N-doped Czochralski silicon (Cz-Si:N), irradiated with 5 MeV neutrons, D=1x10^{17}cm^{-2} (n-Cz-Si:N), and annealed at up to 1400 K (HT) under Ar hydrostatic pressure (HP) up to 1.1 GPa, are investigated. Processing of Cz-Si:N and n-Cz-Si:N at 1270 K and 1400 K, especially under HP, results in a formation of oxygen-related defects, e.g. processing at 1400 K under 1.1 GPa favours a creation of spheroidal SiO_{2-x} precipitates. Neutron irradiation and subsequent HT-HP processing enable to prepare Cz-Si:N with specific microstructure.

Key words: *Cz-Si, nitrogen, neutron irradiation, annealing, hydrostatic pressure, oxygen-related defects.*

Nitrogen admixture in oxygen-containing Czochralski grown silicon (Cz-Si) affects strongly its properties [1,2]. Processing of Cz-Si:N at 1000-1400 K (HT) under enhanced hydrostatic pressure (HP) results in enhanced oxygen precipitation with creation of numerous oxygen-related defects [3].

The effect of sequential treatment (HT $\leq$1400 K, HP exerted by Ar up to 1.1 GPa) on creation and transformation of oxygen-related defects in P-doped Cz-Si with interstitial oxygen content, c_o=8.3x10^{17} cm^{-3}, admixed with nitrogen to c_N=2x10^{15}cm^{-3}, and irradiated with 5 MeV neutrons at 1x10^{17}cm^{-3} dose, is now investigated by infrared (IR) and X-ray / synchrotron methods (topography at DESY HASYLAB Hamburg, X-ray reciprocal space mapping, XRRSM).

Pre-annealing of reference Cz-Si:N and of neutron-irradiated n-Cz-Si:N at 723 K produces so-called thermal donors (TDs); some of them can serve as the nucleation centres (NC's) for subsequent precipitation of interstitial oxygen. The effect of such pre-annealing on the creation of defects after processing of pre-annealed samples at 1270 K under HP (such processing affects markedly oxygen precipitation, especially under HP [4]) is now confirmed by synchrotron topography (Fig. 1) and X-ray measurements (Fig. 2).

TO-16

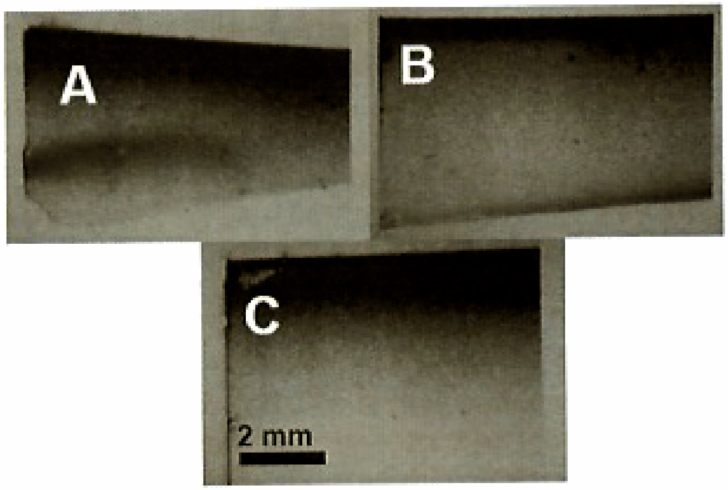

Fig. 1. Section topography of samples pre-annealed for 10 h at 723 K and subsequently processed for 5 h at 1270 K under 1.1 GPa: n-Cz-Si:N pre-annealed under 1.1 GPa (A), Cz-Si:N pre-annealed under 1.1 GPa (B), n-Cz-Si:N pre-annealed under 10^5 Pa (C). Topography recorded at the F1 and S2 stations of the DORIS III synchrotron in HASYLAB (Germany).

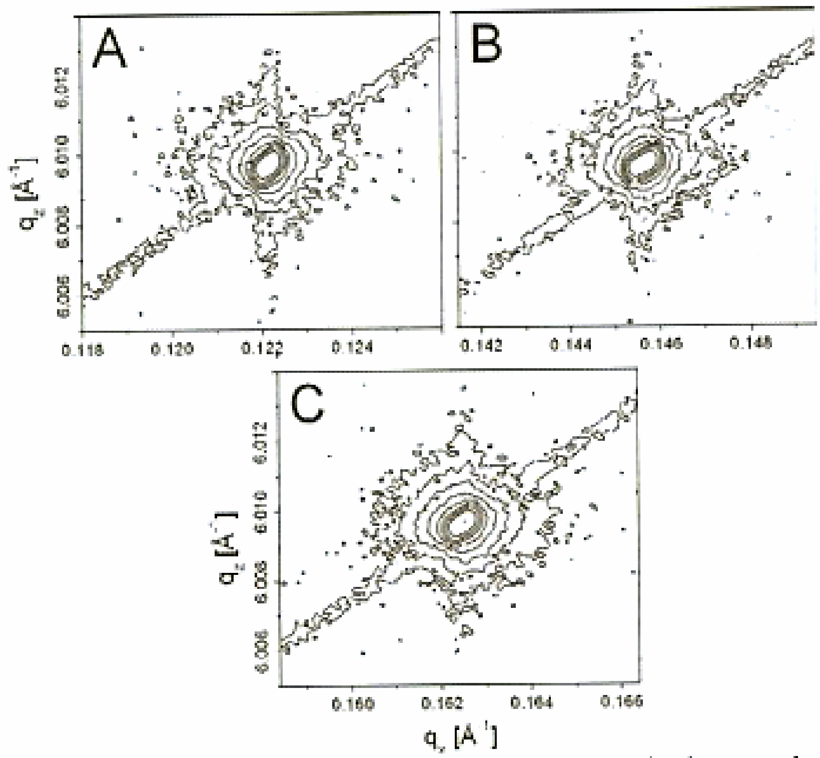

Fig. 2. XRRSM's of samples pre-annealed for 10 h at 723 K and subsequently processed for 5 h at 1270 K under 1.1 GPa: n-Cz-Si:N pre-annealed under 1.1 GPa (A), n-Cz-Si:N pre-annealed under 10^5 Pa (B), Cz-Si:N pre-annealed under 1.1 GPa (C). Axes are given in reciprocal space lattice units (rlu).

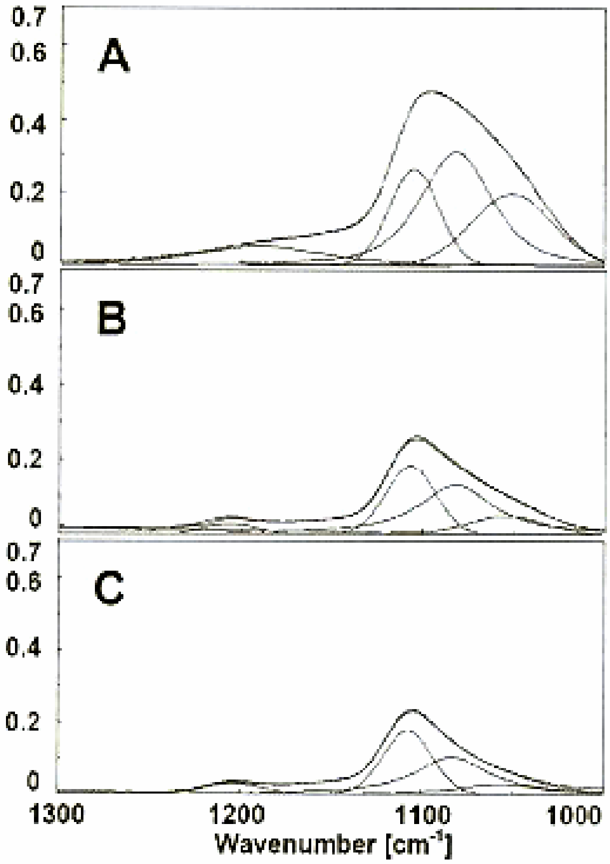

Fig. 3. Deconvolution of IR spectra of pre-annealed samples after processing for 5 h at 1400 K under 1.1 GPa: A - n-Cz-Si:N pre-annealed for 10 h at 723 K under 10^5 Pa + for 5 h at 1270 K under 1.1 GPa, B - n-Cz-Si:N pre-annealed for 10 h at 723 K under 1.1 GPa + for 5 h at 1270 K under 1.1 GPa + for 5 h at 1400 K under 10^5 Pa, C - Cz-Si:N pre-annealed for 10 h at 723 K under 10^5 Pa + for 5 h at 1270 K under 1.1 GPa.

The defect density was the highest for n-Cz-Si:N pre-annealed at 723 K under 1.1 GPa (so with the highest concentration of TDs – compare Fig. 1A), lower for Cz-Si:N pre-annealed also under 1.1 GPa (Fig. 1B), and the lowest for n-Cz-Si:N pre-annealed under 10^5 Pa (Fig. 1C). This means that both NC's created by pre-annealing at 723 K as well as the ones produced by neutron irradiation are contributing to the creation of defects at annealing.

Similar conclusions can be drawn from X-ray reciprocal space mapping (Fig. 2). While XRRSM's are quite similar, the lower intensity of diffusively scattered X-rays (Fig. 2B) for the n-Cz-Si:N sample pre-annealed at 723 K under 10^5 Pa, in comparison to that for the samples processed under HP (Figs 2A and C), suggests important role of TDs in the creation of oxygen-related defects (the concentration of TDs increases markedly with HP applied at processing at 723 K).

Processing at even higher temperature results in complicated transformations of earlier created defects (Fig. 3).

While processing of Cz-Si:N and of n-Cz-Si:N for 5 h at 1270 K under 1.1 GPa results in the creation of numerous small defects, the treatment at 1400 K under HP, especially of n-Cz-Si:N, produces also the spheroidal SiO_{2-x} precipitates [5], more numerous than these in the similarly treated reference Cz-Si:N samples (the peak near 1210 cm^{-1}, compare Fig. 3A with 3B and C).

Neutron irradiation of Cz-Si:N introduces specific NCs of VO_x type [6] for subsequent oxygen precipitation, as revealed especially after processing under HT-HP. This means that neutron irradiation and subsequent HT-HP treatment make it possible to prepare Cz-Si:N with specific microstructure. On the other hand, investigation of n-Cz-Si:N (Cz-Si:N is considered as relatively hard in respect of irradiation damages) after its subjecting to the HT-HP treatment can contribute to determination of its irradiation history and, possibly, can be applied for the post-irradiation dosimetry (compare [7]).

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