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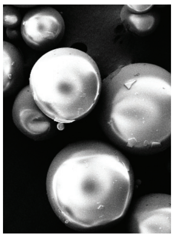
A. Rojek,
A. Kowalik,
J. Podgórski

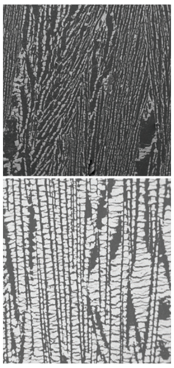
The article presents the investigation to develop a technology for fabricating micro-and nanostructures of a high dimensional precision using the processes of Hot Embossing Nano Imprint Lithography. The research was carried out for three thermoplastic polymers, i.e. poly(methyl methacrylate), olefin copolymer and polycarbonate in order. The process parameters and pattern correction coefficients for shrinkage compensation have been determined. The accuracy better than 1.25 x 10^{-3} % has been reached for the pattern replicated onto olefin copolymer substrates.



8 **Covering glass microspheres with Al_2O_3 or AlN by low-temperature atomic layer deposition**

R. Stankiewicz
A. Piątkowska

Thin layers of Al_2O_3 and AlN were deposited on the surface of borosilicate glass microspheres in an ALD reactor at 50 and 150°C, respectively. They were imaged by SEM microscopy. X-ray EDS spectroscopy was used to assess chemical composition but it was also the basis for a thickness determination method. Al_2O_3 layers between 20 and 100 nm were obtained, with a constant growth rate of 1.2 Å per deposition cycle. AlN formed continuous but always very thin films on the spheres, generally 5 to 10 nm, even if it was growing much thicker on control glass slides, at 0.8 Å per cycle.



16 **Fabrication of ceramic porous structures using the freeze-casting method**

P.Gołębiewski,
K. Kaszyca,
A. Wajler,
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In this paper we describe the construction of an apparatus for a method of unidirectional freeze-casting of ceramic suspensions. The cooling system is based on a cascade system with Peltier modules. The compositions of the suspensions were elaborated in two different systems of the superplasticizer (dispersing agent)/binder additives. Applying the freeze-casting method, zirconium dioxide powder (stabilized with 3% at. of yttrium oxide) was used to fabricate the ceramic matrices, which were then vacuum-infiltrated with a commercially available epoxy resin EpoFix (Struers). SEM microphotographs showed that the porous ceramic materials of a layered structure had been obtained. These layers were arranged into domains of different orientations in relation to each other, while in the domains the layers were arranged in parallel to each other. A mechanism of the processes occurring during freezing the ceramic suspensions was described on the basis of the SEM images of the cross-sections of the produced samples. We observed the key-effect of the additives (superplasticizer, binder) on the microstructure of the samples. That influence can be explained by a change in the freezing mechanism or a change in the ice crystal structure in a system containing those additives.

On the cover:
Ceramic - metal feedthroughs.

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The *Institute of Electronic Materials Technology* develops advanced innovative production technologies of materials characterized by a perfect crystallographic structure and excellent properties, as well as components based on these materials. The scope of R&D activities carried out covers the following areas:

Materials for next-generation components:

- graphene;
- topological insulators;
- materials for spintronics;
- self-organising materials;
- photonic crystals, including plasmonic materials and metamaterials.

Materials for energy generation, storage and transfer:

- wide gap semiconductors, including silicon carbide for GaN HEMT transistors;
- semiconductor-doped glass optical fibres for photovoltaics;
- eutectic materials for photovoltaics;
- SiC wafers and SiC epitaxial layers;
- glass-ceramic seals for fuel cells;
- thermoelectric materials;
- inert matrices for a safe storage of radioactive waste;
- electrode materials for lithium ion batteries;
- ceramic-metal composites and FGMs.

Materials for photonics:

- materials for III-V based semiconductor lasers (obtained using GaAsP, InGaP, AlGaAs, GaAs, GaSb and InP), wafers, epitaxial structures;
- GaN-based epitaxial structures;
- materials for solid state lasers, produced using strontium-calcium niobate;
- infrared photodetectors and UV photodetectors;
- oxide crystals for lasers, passive Q modulators, scintillators, electro-optical and piezoelectric devices, substrates for superconducting HTSc layers;
- glass and ceramics with carefully designed spectral characteristics, including transparent ceramics;
- diffractive optical elements and microlenses;
- nanostructured thin layers;
- luminescent nanopowders and nanocrystals;
- optical fibres and waveguides, including active and photonic fibres.

Materials for electronics:

- silicon monocrystals (standard Si wafers and Si wafers with special properties);
- porous silicon;
- silicon foils;
- epitaxial layers on silicon;
- SiC wafers and SiC epitaxial layers;
- nanopowders and polymer-based powders, pastes and inks for printed electronics;
- photosensitive pastes;
- piezoelectric crystals;
- ceramic-metal composites;
- super-pure metals.

Components:

ITME has elaborated a great number of innovative electronic components based on the manufactured materials, for instance:

- optical fibres (active and photonic), filters, diffractive lenses, two-dimensional photonic microstructures;
- passive elements on membranes (sensors);
- filters, resonators, sensors and actuators based on surface acoustic waves;
- semiconductor devices (lasers, transistors, photodetectors, Schottky diodes);
- solid state lasers and microlasers.

The manufacture of state of the art components is possible at ITME due to high-tech equipment enabling:

- design and manufacture of masks;
- deposition of dielectric thin films ($Si0_2$, Si_3N_4 , AIN);
- multilayer metallization;
- use of lithography: contact printing using deep UV, electron beam pattern generation;
- application of various etching techniques, including reactive ion etching and controlled sidewall etching.

Advanced methods of material properties investigation:

The characterization of materials is performed at ITME by the following methods:

- standard chemical analysis and spectral instrumental methods (flame atomie emission spectrometry, atomie absorption spectroscopy, ultraviolet to far-infrared spectroscopy);
- Mössbauer spectroscopy (conventional, conversion electron method, X radiation method and unique "Mössbauer" method developed at ITME);
- X-ray powder diffraction using the Rietveld method, High Resolution X-ray diffraction, X-ray reflectometry and X-ray diffraction topography;
- scanning electron microscopy and a method based on synchrotron radiation;
- electron paramagnetic resonance;
- atomie force microscopy;
- standard thermal methods (high-temperature microscopy, thermogravimetry, differentia!thermal analysis, dilatometry, etc.) and X-ray methods;
- mechanical methods (testing resistance, friction, hardness, etc.);
- optical methods (microscopy, absorption, reflectometry).

Methods of electronic and photonic components investigation:

ITME tests optoelectronic, microelectronic and piezoelectric devices, using special techniques enabling the characterization of components, including:

- I-V and C-V measurements;
- deep level transient spectroscopy;
- impedance measurements and the measurements of scattering matrix elements up to the frequency of 20 Ghz;
- noise measurements;
- analysis of operational parametres of lasers and photodetectors.