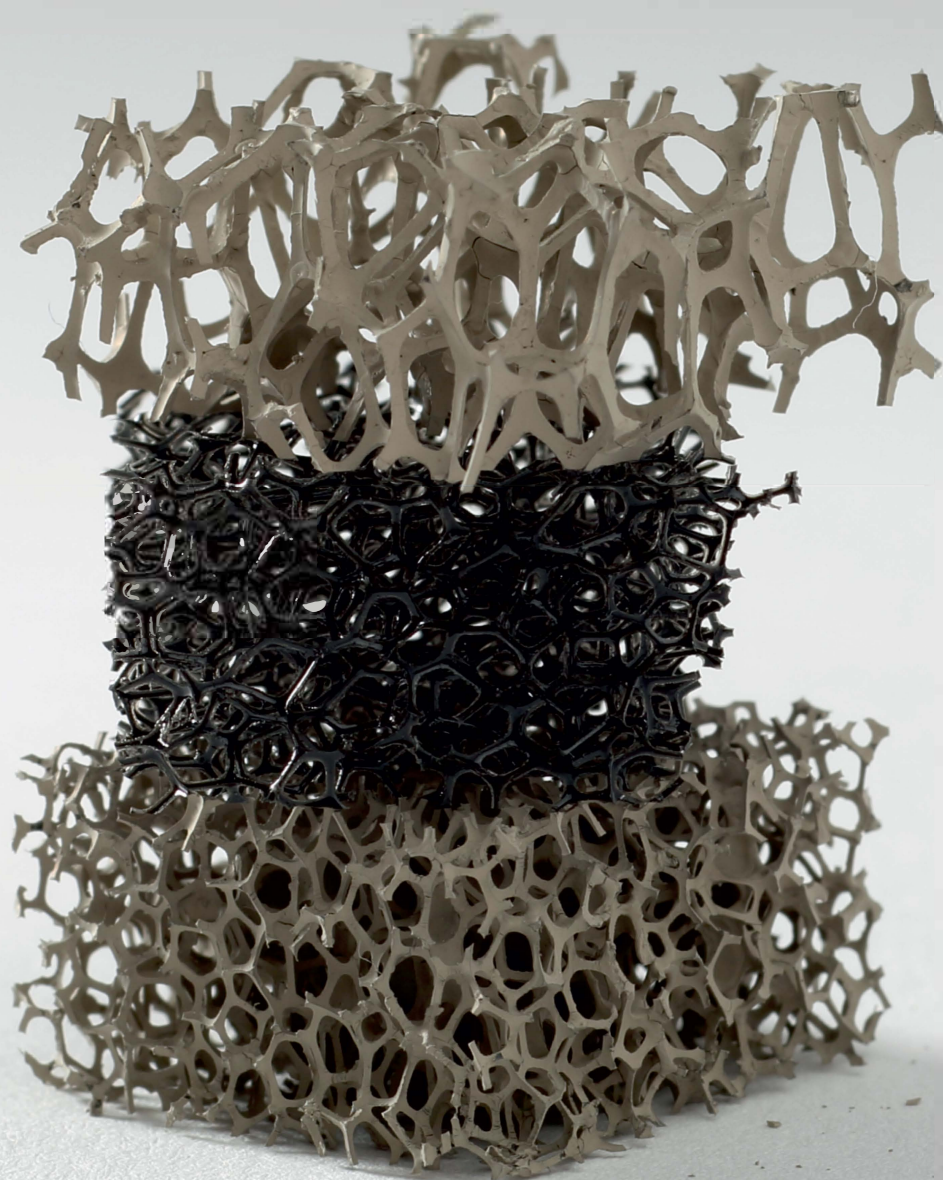


MATERIAŁY

PL ISSN 0209-0058

ELEKTRONICZNE

ELECTRONIC MATERIALS



1

Vol. 45
2017



INSTYTUT TECHNOLOGII MATERIAŁÓW ELEKTRONICZNYCH
INSTITUTE OF ELECTRONIC MATERIALS TECHNOLOGY

<http://rcin.org.pl>



*Institute of Electronic
Materials Technology*

Laboratory of Epitaxy

WE OFFER:

Silicon epitaxial wafers

with parameters:

- 2 - 10 $\mu\text{m} \pm 4\%$ / 0.005 – 5 $\Omega\text{cm} \pm 10\%$
- 10 - 50 $\mu\text{m} \pm 5\%$ / 5 – 100 $\Omega\text{cm} \pm 15\%$
- 50 - 100 $\mu\text{m} \pm 8\%$ / 100 – 300 $\Omega\text{cm} \pm 20\%$

and also:

Measurements of the resistivity profile (carrier concentration) using the spreading resistance method in a point contact on a bevelled sample.

**Measurements of the properties of defect centres
in semiconductor materials, using the DLTS, HRPITS and EPR methods.**

Institute of Electronic Materials Technology,

Department of Experimental Production

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<http://rcin.org.pl>

INSTITUTE OF ELECTRONIC MATERIALS TECHNOLOGY

**MATERIAŁY
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ELECTRONIC MATERIALS**

QUARTERLY

**Vol. 45, No. 1
2017**



Ministry of Science
and Higher Education
Republic of Poland

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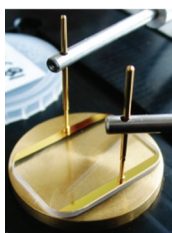
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CONTENTS **4** Effect of Ti and Zr additions on wettability and work of adhesion in Ag/C system

Wettability in the silver/carbon system was examined by the sessile drop method under vacuum at the temperature of 1243 K. Vitreous carbon, diamond and graphite were used as solid substrates. After wettability tests, the solidified Ag/C and Ag-X/C (X - 1 wt.% Ti or Zr) couples were subjected to structural characterization by SEM and EDX analysis. Liquid pure silver does not wet these substrates and shows weak adhesion, regardless of the type of the carbon material used. The introduction of 1 wt.% carbide forming additions Ti or Zr into silver changes dramatically the interaction in the Ag/C system leading to the formation of continuous reaction product layers (TiC_x and ZrC_x , respectively) at the drop/substrate interface. These interfacial layers are responsible for good wetting and high work of adhesion between AgTi1 and AgZr1 alloys and all types of carbon materials examined in this study.

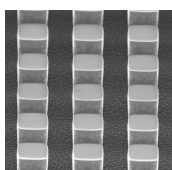
D. Wójcik-Grzybek,
K. Frydman,
N. Sobczak,
R. Nowak,
A. Piątkowska,
K. Pietrzak



12 The use of thermal mapping in evaluation of mechanically induced electrical degradation of graphene - based transparent heaters

The purpose of this study is to investigate temperature distributions of graphene-based transparent heaters deposited on glass. Furthermore it analyses the influence of layer discontinuities such as scratches and cracks on the performance of Joule-heated samples. Graphene mechanical strength was examined by the nanoscratch method at incremental loads using a ball on a flat sample surface. In the case of the controlled load several scratches were produced on the graphene surface. Tribological tests were conducted at different constant loads. The paper presents scanning electron micrograph (SEM) observations of the modified graphene surface. Infrared imaging of Joule-heated samples indicates a significant uniformity deterioration of the thermal maps due to the current flow alteration in the presence of structural imperfections. The results obtained in the course of this study give new insight into the role of defects such as cracks or discontinuities in the overall performance of graphene transparent layers.

A. Kozłowska,
G. Gawlik,
A. Piątkowska,
A. Krajewska,
W. Kaszub



18 Evaluation of hydrophobic properties of organic layers modified with graphene flakes

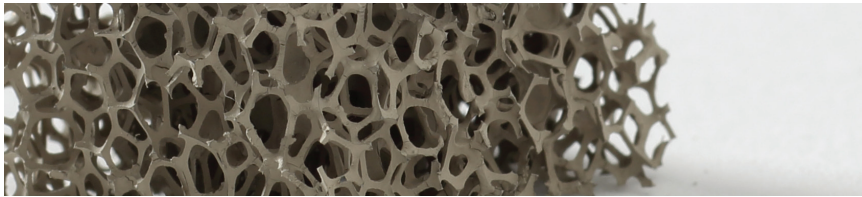
The paper presents the results of our research on graphene composites with organic polymers in various media. The following composites have been tested: PVDF/DMF/GR, PVDF/NMP/GR, PVDF/acetone/toluene/GR and PMMA/GR. The main purpose of this study is to evaluate hydrophobic properties of the selected materials by the contact measurements angle using the static method. The highest obtained value of the contact angle approached 180° for a superhydrophobic composite PVDF/acetone/toluene/GR.

B. Stańczyk,
K. Góra,
K. Jach,
L. Dobrzański

**On the cover:**

Ceramic foams made from silicon carbide and polyurethane matrix used to their production. Application: filters, catalyst carriers, ceramic-metal composites component

Sample from dr Katarzyna Jach.

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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 (SiO_2 , Si_3N_4 , AlN);
- 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 atomic emission spectrometry, atomic absorption spectroscopy, ultraviolet to far-infrared spectroscopy);
- Mössbauer spectroscopy (conventional, conversion electron method, X radiation method and unique "rfMössbauer" 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;
- atomic force microscopy;
- standard thermal methods (high-temperature microscopy, thermogravimetry, differential 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 parameters of lasers and photodetectors.