# Composite graphene membranes for water purification.

G. Romaniak[1,2], K. Dybowski[1], P. Kowalczyk[1], A. Sobczyk-Guzenda[1], B. Januszewicz[1], A. Jędrzejczak[1], W. Szymański[1], Ł. Kołodziejczyk[1], P. Kula[1], T. Kaźmierczak[2], J. Siniarski[2], P. R. Kidambi[3]

[1] Faculty of Mechanical Engineering, Institute of Materials Science and Engineering, Lodz University of Technology 1/15 Stefanowskiego St., 90-924 Lodz, Poland

[2] *Amii Sp. z o.o.,22 Techniczna St., 92-518 Lodz, Poland*

[3] *Department of Chemical and Biomolecular Engineering, Vanderbilt University, Nashville, Tennessee 37212, USA*

grzegorz.romaniak@dokt.p.lodz.pl

Large-area graphene has gained much attention as a promising filtration material. It is estimated, that mainly due to one atom thickness, it can have two orders of magnitude better filtration efficiency than current state-of-art polymer filtration membranes. In the literature selective transport of substances was measured through graphene grown via the CVD method on solid copper. However, the possibility of using graphene synthesized on liquid metal in these solutions has not been investigated so far.

The properties and structure of HSMG® (High Strength Metallurgical Graphene) graphene, in terms of its possible use in filtration, were examined in this work. A broad material examination was carried out (SEM, Raman spectroscopy, AFM, HR-TEM) as well as diffusion transport measurements. As a result, naturally occurring clusters of subnanometric defects were identified and it was shown that due to their presence, HSMG® graphene is a selective barrier for the transport of ions of various sizes and organic molecules due to their size. Then, a concept was developed, and composite filtration membranes based on this graphene were made. A method of selective sealing of too-large graphene defects from the point of view of filtration has been proposed, using graphene oxide and reduced graphene oxide. Through material examination and filtration tests in the forward osmosis mode, the membrane fabrication method was optimized in terms of obtaining the highest efficiency of the filtration process.

As a result, centimetre-scale semi-permeable membranes based on monolayer, polycrystalline HSMG® graphene were obtained. Thanks to the use of selective masking of defects in graphene, a high degree of blocking of salt ions (≈90%) and spontaneous flow of water induced by osmotic pressure difference, an order of magnitude lower than the best state of art CVD graphene-based membranes were obtained.

The research was supported by POIR.04.01.04–00-0089/15, and POWR.03.02.00-00-I042/16-00.