World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:17, No:12, 2023

Ion Beam Writing and Implantation in Graphene Oxide, Reduced Graphene Oxide and Polyimide Through Polymer Mask for Sensorics Applications

Authors : Jan Luxa, Vlastimil Mazanek, Petr Malinsky, Alexander Romanenko, Mariapompea Cutroneo, Vladimir Havranek, Josef Novak, Eva Stepanovska, Anna Mackova, Zdenek Sofer

Abstract : Using accelerated energetic ions is an interesting method for the introduction of structural changes in various carbon-based materials. This way, the properties can be altered in two ways: a) the ions lead to the formation of conductive pathways in graphene oxide structures due to the elimination of oxygen functionalities and b) doping with selected ions to form metal nanoclusters, thus increasing the conductivity. In this work, energetic beams were employed in two ways to prepare capacitor structures in graphene oxide (GO), reduced graphene oxide (rGO) and polyimide (PI) on a micro-scale. The first method revolved around using ion beam writing with a focused ion beam, and the method involved ion implantation via a polymeric mask. To prepare the polymeric mask, a direct spin-coating of PMMA on top of the foils was used. Subsequently, proton beam writing and development in isopropyl alcohol were employed. Finally, the mask was removed using acetone solvent. All three materials were exposed to ion beams with an energy of 2.5-5 MeV and an ion fluence of $3.75x10^{14}$ cm^{-2} (1800 $nC.mm^{-2}$). Thus, prepared microstructures were thoroughly characterized by various analytical methods, including Scanning electron microscopy (SEM) with Energy-Dispersive X-ray spectroscopy (EDS), X-ray Photoelectron spectroscopy (XPS), micro-Raman spectroscopy, Rutherford Back-scattering Spectroscopy (RBS) and Elastic Recoil Detection Analysis (ERDA) spectroscopy. Finally, these materials were employed and tested as sensors for humidity using electrical conductivity measurements. The results clearly demonstrate that the type of ions, their energy and fluence all have a significant influence on the sensory properties of thus prepared sensors.

Keywords : graphene, graphene oxide, polyimide, ion implantation, sensors
Conference Title : ICTDMG 2023 : International Conference on Two-Dimensional Materials and Graphene
Conference Location : Tokyo, Japan
Conference Dates : December 04-05, 2023