BOOK OF ABSTRACTS

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Two-dimensional nanomaterials: research and applications

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The discovery of graphene [1] motivated the scientific community to prepare and study other new two-dimensional (2D) materials. The current intense interest about 2D materials is due to their unique properties resulting from their structure. They offer highly specific surface area as well as electronic structures that can achieve new interesting properties. Graphene and/or graphene oxide particles are intensively studied as promising candidates for various applications as materials for energy storage, photovoltaics, electrical and optical sensors, etc. Graphene based biosensors, including modified graphene oxide (GO) particles are intensively studied nowadays. In particular, the hydrophilic character of GO permits the manufacture of reliable, highly sensitive and ultrafast biosensing nanoplatforms.

MXenes are a new class of 2D inorganic materials, discovered by Barsoum and his group in 2011 [2]. MXenes are prepared from MAX phases of the formula $M_{n+1}AXn$, where M is the most common transition metal, A is an element of the 13 or 14 group of the periodic table, and X is usually C and/or N. By etching of the A layers from MAX phase, MXene are formed. The process of etching caused that surface of MXenes contains functional groups e.g., -O, -F, -OH, and hydrophilicity of these 2D particles.

In this work modification of GO and MXene was studied, and application examples of these 2D fillers will be demonstrated.

A new type of graphene-oxide multifunctional nanoplatform was prepared for the detection of tumor cells. In a first step, GO nanolayers were prepared and functionalized with magnetic nanoparticles and a monoclonal antibody (MAb) specific for CA IX cancer marker. Prepared GO platforms were characterized in terms of oxidation, nanoparticle size and exfoliation, using various physical and chemical methods. Magnetic nanoparticles (MNps) were prepared by the chemical precipitation method and their surface was modified by poly-L-lysine. CA IX-specific antibody was attached via an amide bond to a modified magnetic nanoparticle that was conjugated to the GO platform again via an amide bond. After performing toxicological tests on a cell line, no effect of the cytotoxicity of the multifunctional GO platforms was found. The selectivity of GO-MNps-MAb platforms to target tumor cells has been demonstrated. The results also provided promising evidence of tumor cell targeting with a wide potential for visualization and future tumor treatment [3].

$Ti_3C_2T_z$ MXenes were prepared by the hydrochloric acid/lithium fluoride etching of MAX phase type Ti_3AlC_2. The characterisation of MXenes, and MXene coatings was carried out with XPS, AFM, and SEM analyses [4]. The stability of MXene layers was study within few months by conductivity measurement.

Experimental condition of MAX phase etching and methods of MXene preparation significantly influence the final electrical conductivity of MXenes [5]. It is found that the high electrical conductivity and mobility of MXene can accelerate the charge transfer, what opened opportunities for the use of MXene as potential materials solar cell applications, in batteries and supercapacitors.

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