PREPARATION AND CHARACTERIZATION OF METAL-POLYMER NANOCOMPOSITE MEMBRANES FOR ELECTROCATALYTIC APPLICATIONS

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The synthesis and characterization of Metal NanoParticles (MNP) has attracted great interest of scientists and technologists within the last years due their unique physical and chemical properties, which substantially differ from those of both bulk material and single atoms. These properties provide various practical applications of MNP including catalysis- and electrocatalysis-based processes, which occur in, for example, in fuel cells of different types or in various sensing devices (e.g. amperometric sensors and biosensors). Nevertheless, the main drawback, which still limits their wide applications, is insufficient stability of MNP dealing with their high trend for aggregation and the loos, as the result, of their special properties. Stabilization of MNPs in polymeric matrices of different types has been proven to be one of the most promising strategy to prevent their aggregation and to stabilize their properties [1]. The Polymer-Stabilized MNP (PSMNP) and the polymer-metal nanocomposite materials on their base start to find wide applications in various fields of science and technology. For example, sulfonic ion-exchange resins containing palladium MNP are used as bi-functional catalysts comprising the acid as well as the hydrogenation-active centers. Such catalysts are currently employed in at least four industrial processes.

In this communication we demonstrate that Metal-Polymer Nanocomposite Membranes (MPNCMs) containing MNP can be easily prepared in a Sulfonated PolyEtherEther Ketone (SPEEK) polymeric matrix by using the polymeric membranes as nanoreactors to both synthesize and to characterize the composition and architecture of the formed MNP [2]. Metal ions (or metal ion complexes) are first incorporated in the polymeric matrix where they undergo a reduction reaction that leads to the formation of corresponding MPNCMs. Since this technique allows for carrying out successive metal loading-reduction cycles, it appears to be possible to synthesize the core-shell MNP by changing the type of metal ion in the second or sequential loadings.

In this study MPNCM containing Pt@Cu-PSMNP were prepared and characterized by several techniques, such as TEM (see Fig.1a), SEM (see Fig. 1b), water absorption measurements (see Fig. 2a), impedance spectroscopy (see Fig. 2b) and some others. Some characteristics of MPNCM e.g., water absorption and conductivity) appear to depend on the thickness of platinum shell. The electrocatalytic activity of Pt@Cu-PSMNP has been shown to also depend on this parameter.

References:

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Figures:

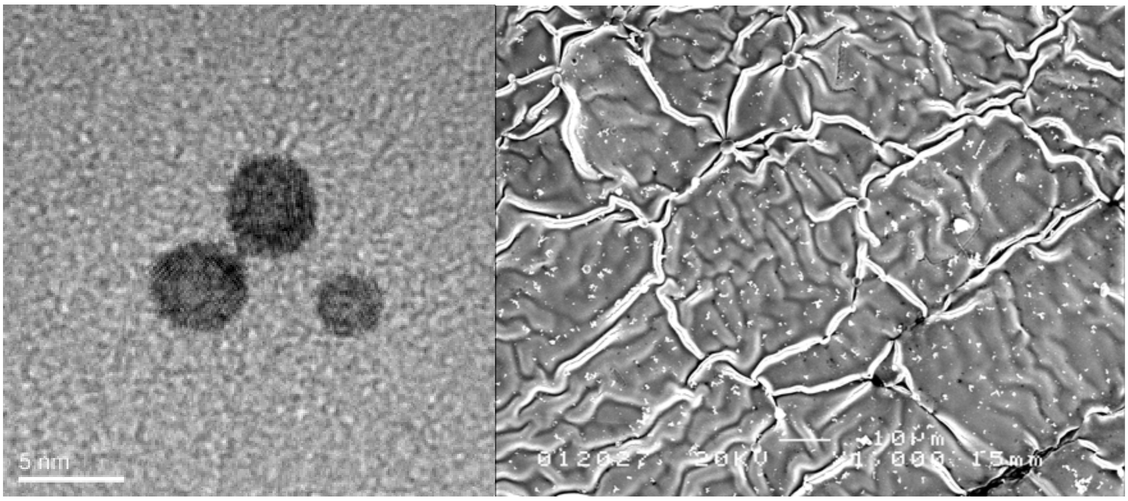

Fig. 1: *Typical TEM images of MPNCMs containing Pt@Cu-PSMNPs (a) and typical SEM micrographies of MPNCMs surface.*

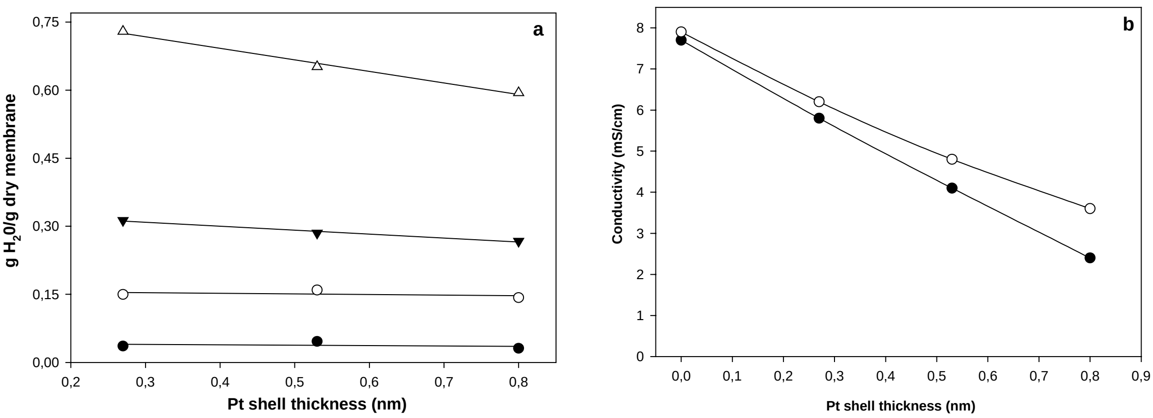

Fig. 2: *Pt-MNP shell thikness influences both (a) the membrane water absorption and the membrane ionic conductivity (b). Water absorption was measured at different values of Relative Humidity (RH): ● 59%, ○ 83%, ▼ 93% and △ 100%. Ionic conductivity was determined by impedance spectroscopy of (○) Pt@Cu-SPEEK and (●) Pt@Cu-SPEEK:SPEEK 1:1 samples.*