

DESCRIPTION FOR THE GENERAL PUBLIC

Low costs of production and light weight of polymeric materials contribute to their increasing use, especially in packaging industry and mobile systems for gas storage. Polymeric materials, like all types of materials, also have some disadvantages. Some of these disadvantages are the limited gas barrier functions, which are related to the structure of polymers. The properties of polymeric materials, including barrier properties, can be modified in different ways, e.g. by surface modification. Improvement of barrier properties can be caused by deposition of the high barrier coating on the surface of material characterized by low barrier functions. Effective barrier coatings include, among others, oxide coatings. One of the methods used to obtain oxide coatings is the sol-gel method, which is based on the hydrolysis and condensation reaction of suitable precursors.

The variety of factors which influence the sol-gel synthesis makes it possible to obtain materials with various properties as a result of the controlling of synthesis parameters. In order to obtain a material with specified characteristics it is necessary to know and understand the processes which take place during the synthesis and the influence of synthesis parameters on the final product. However, it is observed that in some cases improvement of some properties results in deterioration of other properties. This dependence occurs e.g. in the case of barrier and mechanical properties – the improvement of silica films barrier properties by obtaining a very dense structure with small porosity causes increasing fragility of a material. One of the ways to improve the mechanical properties, including increased flexibility, of sol-gel materials is their functionalization.

The relationship between the parameters of the synthesis and the structure and properties is well-known for a nonfunctionalized silica network which forms films, often in a crystalline form. However, there is no in-depth analysis and description of the reactions and phenomena occurring during the formation of the functionalized silica materials, especially in an amorphous form – stabilized in low temperatures. The aim of this project is to understand and analyze the influence of the functionalized silica materials synthesis parameters on their structure, both in the form of a solution (sol) and a solid (coating applied to the polymeric substrate). Moreover, during this project the method of coating deposition with satisfactory adhesion to the polymeric substrate will be developed. The connection between the structure of the obtained materials and barrier properties will also be determined. During the study the analysis of micro- and nano-structure of the obtained materials with small-angle X-ray scattering and spectroscopic examinations (Raman spectroscopy and infrared spectroscopy) will be performed. In the case of coatings also morphology and topography of the surface in micrometric scale will be determined using optical microscopy, scanning electron microscopy and atomic force microscopy. Barrier and mechanical properties of the received materials (polymeric substrate + coating) will be explored. For the determination of the relationships between structure and properties, a correlation analysis of individual properties and the synthesis parameters of functionalized silica materials will be carried out. The received results will be referred to the characteristics of the non-functionalized materials, available in the literature.