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Designing responsive polymer layers: Impact of chain parameters on sensor performance

Abstract:

In the context of optical applications, polymer brushes comprise elongated macromolecular side chains that are covalently anchored to the backbone at one end, with a grafting density sufficient to induce chain extension normal to the surface. This structural arrangement can significantly influence the optical properties of the interface, such as refractive index modulation, light scattering, and surface plasmon resonance. The length and graft density of the brushes can alter their properties such as vapor-swelling ability. In many applications in air, like sensing or smart materials, polymer brushes can be key component in order to achieve desired qualities of the medium. We can say that polymer brush functionalization can impart selective sensing capabilities and improved responsiveness in a wide range of gas sensor architectures. In the present study a newly developed hygrosensitive poly(vinyl alcohol) derivatives comprising grafted poly(N,N-dimethylacrylamide) side chains of varied length and graft density are used as optical sensitive media for humidity detection. Two methods were used to evaluate the changes in the copolymers deposited as thin films in range 150-200 nm when exposed to a different humidity level in atmosphere. First, in order to study the optical sensing properties of the copolymers, reflectance spectra were measured and changes in coating thickness and spectral shift were determined. Second, parallel to that the acoustic properties were examined by monitoring the changes in the mass of the copolymer coating by using the quartz crystal microbalance with dissipation monitoring (QCM-D). The quantity of adsorbed in the copolymer water (water content) was calculated from measured sorption/desorption isotherms. The properties of the copolymer films, their response to humidity, and their potential use as active materials for humidity sensing are debated.

Biography

Katerina Lazarova has been a research scientist at the Institute of Optical Materials and Technologies „Acad. J. Malinowski" for the last 12 years. In 2013 she began her doctorate in the field of photonic crystals and optical sensors based on zeolites and porous materials. In 2016 she became a chief assistant at the IOMT-BAS and from 2019 to 2021 was a postdoctoral fellow with a scholarship in the same field. Currently Dr. Lazarova is Associate professor in Laboratory "Composite and nanostructured materials" working with polymer materials for sensing applications. Author of nearly 50 articles, with awards for presentations in scientific forums and participation in numerous scientific projects in collaboration with other scientific organizations.