OR1007

Investigation of the optical properties of nanoparticle containing thin films produced by a novel plasma coating process as a function of particle size, filling factor and matrix material

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Nanocomposites (NC) consisting of metal/semiconductor nanoobjects embedded in thin film coatings are of growing interest for applications in photovoltaic and advanced data recording because of their optical properties from localized surface plasmon resonance (SPR) induced effects. It is important to tune precisely the SPR induced optical properties, e.g. in thin film stack or gradient structures. Thus it is important to develop a deposition process which allows for an independent control of nanoobject size and its filling factor in the nanocomposite.
A plasma process which is based on a novel approach for producing nanocomposites consisting of inorganic nanoparticles (NP) in organic or inorganic matrix material has been developed by the TU Dresden together with the Fraunhofer FEP. It consists of a NP source based on a gas phase condensation process and a reactive plasma process for the deposition of the matrix material. The separate generation of NPs and matrix material deposition allows for a versatile combination of both components. The NP generation is based on an efficient hollow cathode sputter process and can be scaled up for large area coating.
In this work nanocomposite (NC) thin films deposited by a plasma-aided process are presented which exhibit a localized surface plasmon resonance (SPR) induced absorption. The nanocomposite coatings are fabricated by varying deposition conditions that lead to a change in NP size and filling factor and by using different matrix materials. The effect on NP size and geometry is characterized by electron microscopy. The optical properties of the NC coatings are characterized by UV/VIS spectroscopy and the film structure by electron microscopy. The composition of the coatings is evaluated by x-ray fluorescence methods.
Results show that the optical properties of the films can be tuned from selective absorbers in the case of separated NPs to a broadband absorption in the case of percolative NP networks. The shape and peak position of the SPR induced absorptions can be tuned by varying the NP and matrix material deposition conditions and by thermal annealing leading to coatings with different NP sizes and fill factors.

Keywords
surface plasmon resonance
nanocomposite
PECVD
hollow cathode

nanoparticle