Plasmonic Sensing Technology for Nanomaterial Studies

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Abstract

Nanoplasmonic sensing (NPS) is an optical technology that can be used to detect minute changes in effective refractive index in the vicinity of a sensor substrate. In NPS, the substrate consists of a close-range ordered array of gold nanodisks on a glass support. A thin dielectric film (typically 10 nm Si_3N_4, SiO_2, TiO_2, or Al_2O_3) is used as protective and/or functional layer to protect the gold nanodisks and as substrate material for the sample to be studied. With this approach, virtually any material that can be deposited as a thin or thick film on a substrate can be studied. Examples of sample preparation techniques include; spin-coating, screen printing, dip-coating, and sputtering. During a measurement, changes in the refractive index are monitored in situ, with a time resolution of 1-10 Hz. NPS substrates can withstand harsh conditions, thus in situ measurements can be performed at temperatures up to 600 °C in both liquid and gas ambient and at atmospheric pressure. This makes the technology very useful in general material studies where processes on/within the sample material can be monitored.
Specifically, in this contribution we will show how the extreme surface sensitivity and the small probe depth (sensing volume extends a few tens of nanometers from the gold nanodisks) can be used to scrutinize processes on and within a sample material.
For example, the extremely small probe depth can be used to monitor diffusion in micro- and mesoporous materials. In one study, NPS was used to determine the diffusion coefficient of organic molecules in a thick (>5 μm) mesoporous TiO_2 film [1]. In a similar configuration, the adsorption of CO_2 in a microporous polymer film was studied, and the equilibrium adsorption constant as well as the enthalpy of adsorption was determined [2].
Also, the kinetics of formation of surface supported thin soft matter films can be studied. Specifically, NPS has been used to monitor the adsorption of lipid vesicles and the formation of supported lipid bilayers as well as the dependence on surface energy of those processes [3].
We will also demonstrate how NPS can be used to characterize intrinsic material properties such as the glass transition temperature of polymer films [4].

References

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