Spectroscopic Ellipsometry Focus Topic
Room Ballroom A - Session EL-TuP

Spectroscopic Ellipsometry Poster Session

EL-TuP-2 Unraveling the Ultra-Violet Active Chiroptical Response by ZrO_2 Helical Nanostructures, ***Ufuk Kilic***, *M. Hilfiker, S. Wimer, S. G. Kilic, C. Argyropoulos, E. Schubert, M. Schubert,* University of Nebraska-Lincoln

Chirality, the handedness of a material, which cannot be made superimposable on its mirror image by using simple symmetry operations (ie. translation or rotation). This symmetry breaking phenomenon has recently gained unprecedented attention due to its pivotal roles in the sub-fields of physics, chemistry, biology, and pharmacy [1]. Briefly, chiral-materials have the differential absorption properties of two possible spin states of photons: left- and right-circularly polarized light. However, the chirality of molecules found in nature is very weak and almost impossible to spectrally tailor their response. Moreover, the absorption bands of optically active chiral molecules typically appear in the deep ultraviolet part of the spectrum [2]. Using metamaterial platforms to sense these chiral molecules is challenging because majority of them are designed to operate in the infrared to visible spectral range [1,3,4]. The use of ultra-wide band gap metal oxides in the fabrication of nanostructures has been seldom discussed in the literature and investigations on their chiral properties remained almost untouched [4].

Our theoretical studies showed that one can get deep-ultra violet strong chirality response from ZrO_2 helical nanostructure design. Hence, using a recently emerging bottom-up, wafer-scale, 3D nano-morphology fabrication technique so-called glancing angle deposition, we successfully fabricated helical nano-structures from ZrO_2 ultra-wide band gap metal-oxide. By using the Mueller matrix generalized spectroscopic ellipsometry technique, the experimental chiroptical characterization was performed and verified the theoretically predicted existence of UV-active chiroptical response from the proposed ZrO_2 nanohelical metamaterial platform.

We envision that such nanostructure design with large chirality signals in the UV range of wavelengths, where the electronic transitions for biomolecules often occur can open a new avenue for their potential use in the next generation chiral sensor, bio-imaging, polarization bio-encryption or chiral-photonics device applications.

References:

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[3] Kilic, Ufuk, et al., *Advanced Functional Materials* 31.20 (2021): 2010329.

[4] Sarkar, Sumant, Ryan O. Behunin, and John G. Gibbs, *Nano letters* 19.11 (2019): 8089-8096.

EL-TuP-4 A Review of Refractive Index Refinements Analysis in Mono layers Absorbents Atomic Layer Deposition (ALD) or Molecular Physisorption Phenomena, *F. Ferrieu,* Optical Polarimetry Ellipsometry, Switzerland*;* ***Christophe Vallee****,* SUNY POLY, Albany

In situ Spectroscopic Ellipsometers (SE), is a precious real time process control tool. As frequently reported in literature, very thin layers measurements don't yield however simultaneous and uncorrelated values for the thickness t_F and the material refractive index (ri). Thickness values are highly related with the choice of an a priori assumed ri which a characteristic of the intrinsic layer's nature. The paper implements an earlier analysis of the initial Drude equations. We show that when thickness turns ultra-thin thenthe ellipsometry equations can be solved through a first order expansion in t_F. During growth, deposition or in thecase of physical adsorption on a substrate, this hypothesis is entirely fulfilled. After describing the simple way to proceed data, within Atomic Layer Deposition (ALD) examples, it is shown how few physi-sorbed monolayerscase can be handled so far. More general molecular physisorption is also considered. Particularly in theCO_2/H_2O gas adsorption inter exchange, ellipsometry turns a right method with absorbent like thin or nativesub-oxide samples. Both refractive index and thickness with high accuracy are independently reachable andwithin a rather fast acquisition capability. This will be shown in this poster.

Moreover, in vacuum chambers, the stability of alignment is just being done one time and fully optimized. A fixed physicalconfiguration inside vacuum chambers acts with benefit over usual limiting factors. An evident interest appearsin atomic layer deposition or etching as well for molecular beam epitaxy and chemical vapor depositionstechniques, and sputtering. With today's "no moving part" or "one single shot" photonic technologies,Spectroscopic Ellipsometers within this configuration can provide sensitivity more than Surface PlasmonResonance SPR which measures only the optical thickness. With the use of a limited number of wavelengths,SE exist in wide applications fields and furthermore depolarization factor acquisition gives an additionalinformation on the player building accomplishment. Since the pioneer works from H. Arwin, a large opening forbio photonics sensors appears also today. Thin silica interacting with ambient is recognized as specific adsorbents material for gases and proteins detection which is observed here in "native" oxides layers.

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