Tutorial on Spectroscopic Ellipsometry: A Powerful Tool for Optical Materials Characterization

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Date: Monday, May 6
Time: 10am - 12pm, followed by lunch (provided)
Location: 12-0168, MIT.nano basement seminar space

The theory of polarized electromagnetic wave propagation in optical media and interfaces will be briefly summarized. The material interaction with light is introduced based on the band structure concept and concluded in the derived optical properties. Spectroscopic ellipsometry will be defined and corresponding metrology instrumentation described. The measurement data analysis based on physical concepts as well as advanced formalism including optical anisotropy will also be presented. Finally, typical use cases of the ellipsometric method will be shown such as problems of in-situ thin film growth, temperature dependent functions, or applications in optoelectronics.

Peter Basa received his Ph.D. in physics from the Budapest University of Technology in 2009. He specialized in materials science and optics, and has 15 years’ experience in spectroscopic ellipsometry applications and metrology. He was a research group leader in the Institute for Materials Science of the Hungarian Academy of Sciences, and today the department leader and product manager for optical thickness metrology tools at Semilab Semiconductor Physics Laboratory Co. where he works for 9 years now. Semilab is a private company with strong profile on semiconductor and research metrology instruments, headquartered in Budapest, Hungary.

Agenda:
1. Polarization, birefringence, polarizers
2. Reflection and refraction at interfaces
3. Optical dispersion in materials: dielectrics, semiconductors, metals
4. Physical origins of the refractive index: band structure and Van Hove singularities, crystal symmetry, low-dimensional systems and quantum confinement
5. Principles of spectroscopic ellipsometry
   o Theory of measurement
   o Instrumentation
   o Data analysis and optical modeling
   o Reliability and interpretation of results
   o Optical anisotropy and advanced formalism (Jones Matrix and Mueller Matrix formalism)
   o Scatterometry and reflection from periodic structured surfaces
6. Application examples
   o Thin film growth: in-situ applications
   o Dielectric films: temperature dependent functions, Mott-transition
   o III-V semiconductors: GaAs and GaN materials for optoelectronics.