Roadmap of ellipsometric characterization of plasmonic nanoparticles

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Abstract

This talk argues the importance of Spectroscopic ellipsometry (SE) SE for the metrology of plasmonic NPs. The shape distribution, the gradient of concentration of NPs as well as the number of NPs in nanostructures can be estimated by analyzing ellipsometric spectra with an adequate model such as shape distributed effective medium theory SDEMT [1] or coupled dipole model (CDM). This technique takes the advantage of the high sensitivity of SE and the strong dependence between plasmon band and the shape and organization of NPs. Since SE is a non-local characterization tool, this technique gives statistically significant distribution. Thus, SE can be considered as an alternative to TEM for the characterization of plasmonic materials. We now discuss the future trends of SE characterization of plasmonic NPs.

With the improvement of the NP synthesis routes, more and more complex nanostructures are investigated such as alloy NPs, nanocubes[1], hollow NPs[2], or core-shell NPs[3]. We expect that all parameters, which have a significant impact on the plasmonic resonance of NPs, such as the NP composition or shell thickness, can be determined from SE. In addition, nanostructure composed of self-assembled NPs can be used to manipulate the polarization of light. As the plasmon modes of anisotropic NPs can be selectively exited by specific polarization state of light, ellipsometry can be used to evaluate the orientation of NPs or the chirality of nanostructure[4]. The challenge remains the development of models, which capture the main physical properties of plasmonic nanostructures. Rigorous methods, based on the resolution of the Maxwell equation can be applied to a large number of nanostructures but require large computing resource. Other approaches based on homogenization procedures are less computing time consuming. However, their domain of validity is more restricted and new effective medium theory must be developed for each studied nanostructure.

References

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