Particle Characterization by means of White Light Scattering

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In this paper recant development in characterization of spherical nanoperticles with monotonically variable size suspended in plasma is reported. Method is based on solving the reversed problem of light scattering from spherical particles which radius is monotonically changing in time e.g. particle growth or etch in plasma. The measurements are in-situ and nonintrusive requiring three optical exes: one for illumination of particle cloud by white light and two for measurement of the spectra of the scattered light. As a result the wavelength dependent refractive index of particle suspension is reconstructed together with time dependent radius.

1. Experiment

Many different experimental methods were reported for diagnostic of spherical particles suspended in plasma. However most of them require moving parts, multiple optical axes, complicated optics or long measurement. Method presented here overcomes all these problems and leaves space for more improvements.

The experiments are done in PK−4 setup [1], which is laboratory prototype of parabolic flight and future International-Space-Station-based complex plasma facility. The hart of the setup is long cylindrical 30 mm diameter glass tube. Plasma is generated by 81 MHz RF current driven through the loop of wire around the tube.

Two types of experiments were done. First, scattered light from particles grown on argon acetylene mixture were measured [2]. Second, PS particles with known size were etched in Argon oxygen plasma and light evolution were recorded. Assuming that the refractive index of the particles is not time dependent and not varying with size, the evolution of light signal for one wavelength scattered form particles could be reconstructed into the time dependent radius r(t) fitting the refractive indexes for the rest of the illumination spectra using r(t) as time dependent radius. This procedure is repeated until minimal error between reconstructed light intensity evolution and measurement is reached. For light scattering simulation mie theory is used [3].

2.Results

Figure 1. up shows the reconstructed indexes of grown particles for different starting wavelength, blue 725nm, red 746nm and green 781nm. Full lines shows real part on the right y axis while lines with symbols shows imaginary part on the left y axis. Black line, full and with symbols represents refractive index of the 1.3 μm diameter PS particle etched in argon oxygen plasma. In the lower figure respective time dependent radii are shown.

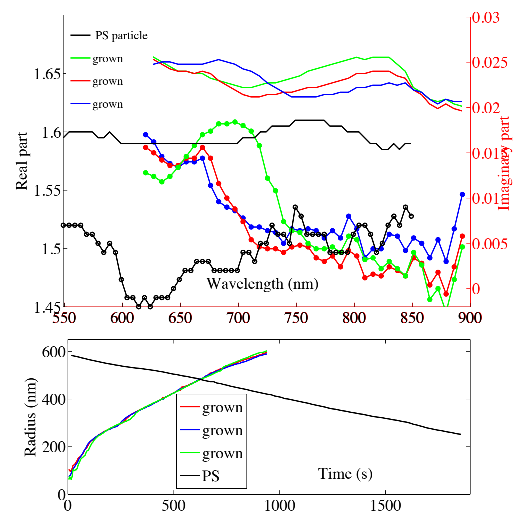

Fig. 1: *Wavelength dependent refractive indexes of grown and PS particles together with their time dependent radii.*

References

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[2] S. Mitic, M. Y. Pustylnik, G. E. Morfill and E. Kovačević, Optics Lett. **36**, 3699 (2011).

[3] We used a Matlab set of Mie-scattering functions by C. Mätzler available at http://www.hiwater.org/Mie_calcs.html.