Quantum dot photoluminescence as charge probes for plasma exposed surfaces

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Excess charges resting on an electrically floating surface immersed in a low pressure argon plasma are detected and qualitatively investigated by time-resolved analysis of variations in the photoluminescence (PL) spectrum emitted by laser excited quantum dots (QDs) deposited on that surface. The experimentally observed fast redshift of the PL spectrum peak is linked to electric fields associated with charges near the surface of the QDs, a phenomenon entitled the quantum-confined Stark effect [1]. Variations of the average surface charge due to variations of the gas pressure and input power are demonstrated to result in different extents of redshift of the PL peak. This amount of redshift is found to be higher for relatively higher input powers and lower for relatively higher gas pressures. In this work we demonstrate that QDs can be used as sensitive and in-situ (nano) probes for surface charge. In connection, also the possibility of using a quantum dot layer on the surface of microparticles immersed in plasma to probe the microparticles' electrical charge is investigated using analytical calculations.

References

[1] Marvi, Z., Donders, T. J. M., Hasani, M., Klaassen, G., Beckers, J. (2021). Quantum dot photoluminescence as a versatile probe to visualize the interaction between plasma and nanoparticles on a surface. Applied Physics Letters, 119(25), 254104.