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X-ray induced energy transfer in nanoscale materials under X-ray irradiation: Experimental and theoretical studies

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A nanoscale probe of calcium phosphate enclosed liposomes filled with sulforhodamine B (SRB) aqueous solution was synthesized and the degradation of SRB in the probes was used to measure the enhanced energy deposition within the nanoscale probes mixed with PEGylated gold nanoparticles under X-ray irradiation. The enhancement was measured as a function of the gold nanoparticle concentration and the results showed a jump at 0.46nM of gold nanoparticles with a slope of 42-fold per one weight percentage (wp–1) of gold in water superimposed on a gentle 1-fold wp–1 slope. Theoretical simulations revealed that the jump was caused by the previously proposed type 2 physical enhancement (T2PE) exerted from a single 90nm gold nanoparticle on a contacting nanoscale probe and the gentler slope by type 1 physical enhancement (T1PE) was caused by the rest of the gold nanoparticles hundreds of nanometers or farther away. The jump is equivalent to a 2-fold absolute enhancement for each nanoscale probe and suggests that T1PE and T2PE obey the addition algorithm. A systematic theoretical study was also carried out to investigate XIET between a strongly X-ray absorbing gold nanoparticles (donors) and a weakly X-ray absorbing hollow silica nanoparticle filled with water (acceptor), where part of the energy absorbed by the donors can be transferred to the acceptor when the two are positioned sufficiently close to each other and under 20–100keV X-ray irradiation. XIET was studied as a function of dimension, composition, configuration and orientation of donors and acceptors, number of donors and X-ray energy. These results provide a theoretical framework to guide future experimental XIET studies.

Biography

Arjun Sharmah completed his PhD from the Department of Chemistry at University of California-Davis in 2016 and is currently a postdoctoral researcher postdoctoral at the same institution working in the field of nanochemistry and nanosensor development for drought sensing in plants.

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