Tapping the Potential of Ionizing Radiations

■ For synthesis of nanomaterials with biomedical and sensing applications

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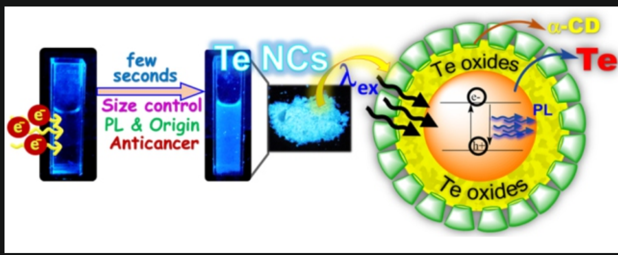
Considering the impending applications of nanomaterials, it is crucial to develop a sustainable and eco-friendly protocol for their synthesis with minimal use of corrosive, flammable reagents and toxic/hazardous chemicals (i.e., precursors, reducing and capping agents). In this perspective, ionizing radiation (e.g., e-beam, gamma-ray) assisted synthesis of nanomaterials is a well-known technique, and do not involve any stringent experimental conditions. More so, this strategy offers many advantages, such as time efficient, scale-up production, one-step approach and *in situ* generation of reducing species (i.e., solvated electron, e^-_{sol}). Additionally, the nucleation and growth processes of the nanoparticles can be conveniently controlled by the suitable choice of the experimental conditions such as absorbed dose, dose rate, host matrix, solvent environment, and capping agent.

Taking account of these advantages, radiation-chemical approach is being used to prepare nanomaterials with unique features which otherwise require complicated synthetic procedures in conventional routes. Some of the highlights of the recent works pertaining to radiation-assisted synthesis of nanomaterials are mentioned below.

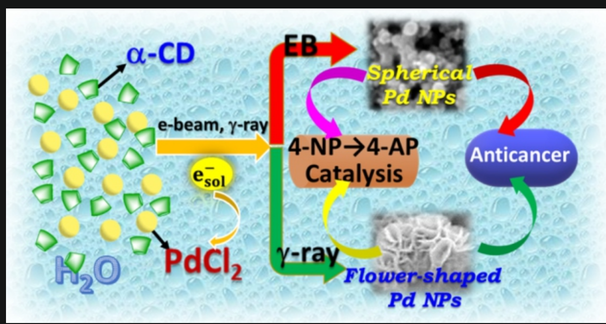
For the first time, blue light emitting amorphous Si-based nanomaterials were prepared in aqueous media using radiolytic method. It was revealed that the nanomaterials were formed *via* hydroxyl radical (·OH) induced reaction. Usage of nanomaterials was demonstrated in anti-counterfeiting & fingerprinting. Further, post-functionalization with glutathione, these nanomaterials exhibited tumor selectivity at lower pH along with cell labelling capabilities and propensity to localize at the nucleus.

Te-based nanomaterials have found an enormous interest in biomedical applications recently. However, anisotropic property of Te makes it difficult to control phase and morphology of its nanomaterials. Radiolytic approach with high dose rate facilitated formation of photoluminescent size controlled, amorphous Te-nanocomposites (NCs). Formation of NCs proceeds through a solvated electron driven reaction. Remarkable concentration-dependent killing was observed only in the case of cancerous cells, while no such trend was seen in normal healthy cells.

The *in situ* generated solvated electrons were used for one-pot highly facile preparation of spherical and flower-shaped Palladium (Pd) nanoparticles (NPs) coated with cyclodextrin molecules. The nanomorphology varied considerably as a function of dose rate, wherein spherical-shaped nanoparticles NPs were formed in case of high dose rate electron-beam assisted synthesis, while nanoflakes self-assembled to form nanoflower-shaped morphologies in γ-ray mediated approach involving low dose rate. Implications of morphology control was observed from the superior catalytic and anticancer properties of flower-shaped Pd NPs as compared to spherical shaped ones. The interplay of dose rate along with soft matrix of molecular assemblies can facilitate morphology tuning of nanomaterials *vis-à-vis* their properties.



▲ Photoluminescent cyclodextrin coated tellurium nanocomposites.



▲ Ionizing radiation (EB and gamma-ray) mediated synthesis of α-CD coated Pd NPs with different morphologies.

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