Radioluminescent colloidal crystalline arrays

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Monodisperse, quaterpolymer nanoparticles are synthesized using an emulsion polymerization procedure to generate fully organic, x-ray active colloidal crystalline arrays (CCAs). These colloidal particulates consist of copolymerized polystyrene as the basis, polydivinylbenzene as a crosslinking agent, poly(propargyl acrylate) to achieve surface functionalization, and poly(anthracene methyl methacrylate) to attain scintillation. These poly(styrene-co-divinyl benzene-co-propargyl acrylate-co-anthracene methyl methacrylate) nanoparticles are able to spontaneously self-assemble into BCC and FCC structures due to the strong coulombic electrostatic repulsive forces between the particles. The rejection wavelength of the CCA can be coupled to the x-ray excited optical luminescence to fine-tune the color characteristics of the liquid crystal. Additionally, encapsulating these CCAs in a poly(ethylene glycol) methacrylate based hydrogel network has advantages over the liquid system in regards to the stability of the crystal structure. While stabilized in the gel, the particulates can be post functionalized with organic dyes such as naphthalimide and rhodamine B using a copper (I) catalyzed azide/alkyne cycloaddition "click" reaction. By coupling the organic scintillator with fluorophores that form x-ray induced sequential Förster Resonance Energy Transfer (FRET) pairs, the hydrogel can be tuned to span the full visible spectrum. Blue-emitting, x-ray excited anthracene transfers energy to green-emitting naphthalimide which can then transfer energy to red-emitting rhodamine B. The rejection wavelength of the CCA stabilized in the hydrogel film can be coupled to the x-ray excited optical luminescence to fine-tune color characteristics, similar to the liquid system.