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Co-Precipitation Method for the Fabrication of Charge-Transfer Molecular Crystal Nanocapsules

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Abstract : When quasi-stable solutions of 9-methylanthracene (pi-electron donor, 0.0005 M) and 1,2,4,5-Tetracyanobenzene (pi-electron acceptor, 0.0005 M) in aqueous sodium dodecyl sulfate (SDS, 0.025 M) were gently mixed, uniform-shaped rectangular charge-transfer nanocrystals precipitated out. These red colored charge-transfer (CT) crystals were composed of a 1:1-mole ratio of acceptor/ donor and are highly insoluble in water/SDS solution. The rectangular crystals morphology is semi hollow with symmetrical twin pockets reminiscent of nanocapsules. For a typical crop of nanocapsules, the dimensions are 21 x 6 x 0.5 microns with an approximate hollow volume of 1.5 x 105 nm3. By varying the concentration of aqueous SDS, mixing duration and incubation temperature, we can control the size and volume of the nanocapsules. The initial number of CT seed nanoparticles, formed by mixing the D and A solutions, determined the number and dimensions of the obtained nanocapsules formed after several hours of incubation under still conditions. Prolonged mixing of the donor and acceptor solutions resulted in plenty of initial seeds hence smaller nanocapsules. Short mixing times yields less seed formation and larger micron-sized capsules. The addition of Doxorubicin in situ with the quasi-stable solutions while mixing leads to the formation of CT nanocapsules with Doxorubicin sealed inside. The Doxorubicin can be liberated from the nanocapsules by cracking them using ultrasonication. This method can be extended to other binary CT complex crystals as well.

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