From flask to devices: Exceptionally functional colloidal quantum emitters and deterministic integration

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Colloidal quantum dots (cQDs) synthesized in simple laboratory flasks are finding real-world applications in demanding technologies from displays and lighting to photovoltaics and photodetectors. In the future, cQDs may be the basis for single-photon devices in quantum networks. Beyond quantum-size control, we pursue an expanded "structural toolbox" to synthetically engineer new quantum emitters with optimal quantum optical properties.[1-9] And, taking advantage of their solution-phase processibility, we advance strategies, such as direct-write placement using scanning-probe techniques,[10,11] for deterministic integration of quantum emitters into photonic and plasmonic platforms to realize properties not accessible through synthesis alone. Here, I will discuss our advances in synthesis of complex cQD heterostructures to enable photons-on-demand and photon purity from the visible through the telecom windows, as well as collaborations in novel hybrid emitter-antenna couples that achieve high-brightness by improving photon directionality and/or providing dramatic emission-rate enhancement,[12,13] e.g., a lithography-free ultrabright (12.6 MHz), room-temperature C-band single-photon source.[13]

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