**Highly-Luminescent Colloidal Nanocrystals of Cesium Lead Trihalide Perovskites ($CsPbX_3$, X=Cl, Br, I)**

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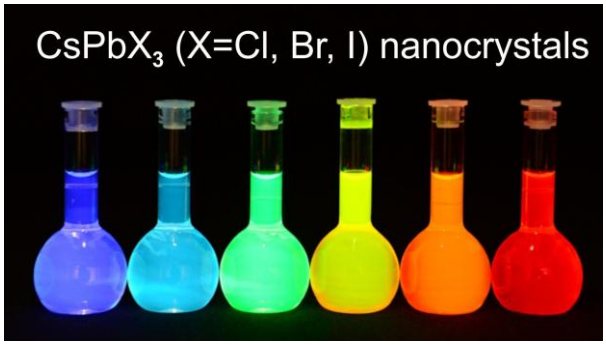
Chemically synthesized inorganic nanocrystals (NCs) are considered to be promising building blocks for a broad spectrum of applications including electronic, thermoelectric, and photovoltaic devices. We have synthesized monodisperse colloidal nanocubes (4-15 nm edge lengths) of fully inorganic cesium lead halide perovskites ($CsPbX_3$, X=Cl, Br, and I or mixed halide systems Cl/Br and Br/I) using inexpensive commercial precursors [1]. Their bandgap energies and emission spectra are readily tunable over the entire visible spectral region of 410-700 nm. The photoluminescence of $CsPbX_3$ NCs is characterized by narrow emission line-widths of 12-42 nm, wide color gamut covering up to 140% of the NTSC color standard, high quantum yields of up to 90% and radiative lifetimes in the range of 4-29 ns.

Post-synthestic chemical transformations of colloidal NCs, such as ion-exchange reactions, provide an avenue to compositional fine tuning or to otherwise inaccessible materials and morphologies. While cation-exchange is facile and commonplace, anion-exchange reactions have not received substantial deployment. Here we present fast, low-temperature, deliberately partial or complete anion-exchange in $CsPbX_3$ NCs. By adjusting the halide ratios in the colloidal NC solution, the bright photoluminescence can be tuned over the entire visible spectral region (410-700 nm). Furthermore, fast inter-NC anion-exchange is demonstrated as well, leading to uniform $CsPb(Cl/Br)_3$ or $CsPb(Br/I)_3$ compositions simply by mixing $CsPbCl_3$, $CsPbBr_3$ and $CsPbI_3$ NCs in appropriate ratios.

We also present low-threshold amplified spontaneous emission and lasing from $CsPbX_3$ NCs [3]. We find that room-temperature optical amplification can be obtained in the entire visible spectral range (440-700 nm) with low pump thresholds down to 5±1 μJ $cm^{-2}$ and high values of modal net gain of at least 450±30 $cm^{-1}$. Two kinds of lasing modes are successfully realized: whispering gallery mode lasing using silica microspheres as high-finesse resonators, conformally coated with $CsPbX_3$ NCs, and random lasing in films of $CsPbX_3$ NCs.




1. L. Protesescu *et al*. Nano Letters **2015**, *15*, 3692–3696
2. G. Nedelcu *et al.* Nano Letters **2015**, 15, 5635–5640
3. S. Yakunin *et al.* Nature Communications **2015**, 9, 8056.