Nanoengineering next-generation energy materials, the case of $CsPbBr_3$ perovskite nanocrystals

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New energy materials promise advantages in the fight for a greener future. New optoelectronic materials, Lead-halide perovskites present excellent efficiencies in photovoltaic and light-emitting applications. The physical properties contrast with recent experimental observations of high dynamic disorder, room temperature structural transformation, and questionable material stability. We study cesium lead halide compositions at the limit of the smallest crystals we can make to understand and better control them. Through synthetic engineering of nanocrystal's shape, we control quantum confinement of excitons with atomic precision (in 2D nanoplates) and achieve anisotropic emission (in 1D nanowires). We discovered a typical strain build-up in two-dimensional $CsPbBr_3$ perovskite nanobelts that results in a structural deformation when adsorbed on carbon substrates. The microstructure is indicative of buckled nanobelts and determined using orientation dark-field imaging (SODFI) technique developed for this project. This method enabled the collection of scattered electrons from solid angles and traced them back to the specific orientation of the crystal. Apparent emission was measured from the buckled nanobelt using cathodoluminescence, signifying tolerance to mechanical deformations of the electronic properties. If time permits, I will discuss new compositions within a double perovskites structure engineered to improve perovskites' infamous toxic-instable reputation.

References

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Figures

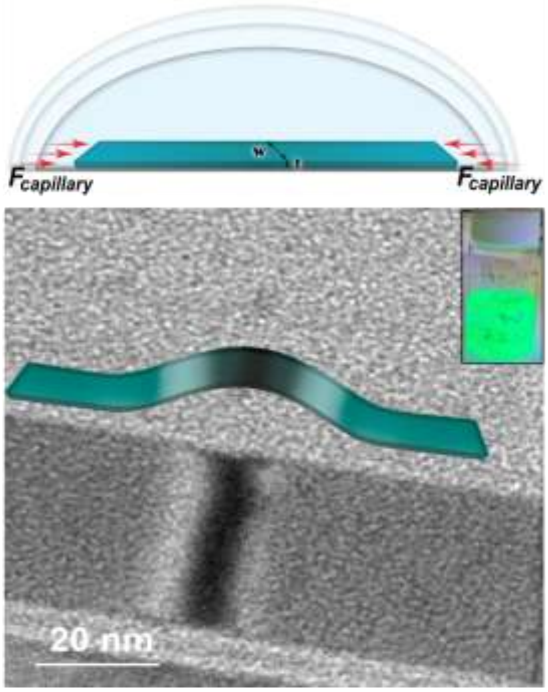

Figure 1: $CsPbBr_3$ colloidal nanobelts present bright emission. Adsorption on carbon substrates results in contrasts bands. Electron and force microscopy tools unravel a typical buckling structural deformation. Advancing perovskites into working technology warrant rational strain engineering.