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Charging of Colloidal Quantum Dots. Spectroscopy and Transport

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Colloidal inorganic semiconductor nanocrystals promise optimized electronic, optical and magnetic properties using size, shape and composition control. It is also interesting to look at the effect of a few charges in such small structures, particularly when placed in the quantum dot states. We observed that charging the colloidal quantum dots leads to electrochromic response covering the visible and IR spectral ranges via changes in the available interband and intraband transitions. In particular, charging the dots leads to reduced absorption at the band edge and this affords a lowered threshold for stimulated emission. Charging also a-priori saturates traps that otherwise impede transport and charged films of quantum dots are indeed observed to be conducting. Shell to shell (S or P) transport has been observed and, to date, the films conduct via a variable range hopping mechanism in the Coulomb-gap regime. These findings will possibly impact the use of colloidal quantum dots in their opto-electrical applications and they more generally provide support to the growing effort to generate novel materials based on self-assembled organic/inorganic nanostructures.