Directed self-assembly – A controllable route to optical and electronic devices based on single nanostructures

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Self-assembled semiconductor quantum dots offer an extremely attractive route to electronic structure control. Size, shape, composition, strain can all be used to tune the electronic structure of individual dots. Although useful, this versatility can also be a major drawback; particularly in devices where one would wish to couple to an individual dot or in situations where one would like many identical copies of a particular single dot structure. By the very nature of the self-assembled growth process, the characteristics of individual dots can vary widely and their spatial location is generally uncontrolled. In this presentation I will discuss how these limitations may be overcome and I will present examples in which control structures such as optical microcavities or electrostatic gates are constructed around individual quantum dots to determine their coupling to the optical field or to tune their electronic structure. Using such techniques I will show how one can engineer the symmetries of individual dots, introduce optical transitions that were previously forbidden and so facilitate the emission of entangled photon pairs.