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Polymer single crystal meets nanoparticle, toward ordered hybrid materials

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Judiciously selected polymer single crystal (PSC) systems can interplay with 1-D and 0-D nanoparticles, forming ordered hybrid structures. In this presentation, I will first focus on patterning PSCs on individual carbon nanotubes (CNT). Using both controlled solution crystallization, thin film crystallization and physical vapor deposition methods, CNTs were periodically decorated with PSCs, resulting in nano hybrid shish-kebab (NHSK) structures. Because the polymer kebabs can be easily removed, these unique NHSKs can serve as templates to fabricate a variety of CNTs-containing hybrid materials with controlled patterning on the CNT surface. Sub-20 nanometer alternating patterning was achieved by using crystalline block copolymers. The mechanism was attributed to the crystallization induced block copolymer phase separation. This pattern was successfully used to template nanoparticles (NP) patterning on CNTs. In the second part of the talk, I will discuss fabricating Janus NPs and patterning these NPs using PSCs. Single crystals of thiol-terminated polyethylene oxide (PEO) were incubated in a gold sol. Au-S bonds were formed between the AuNPs and the PEO single crystal surfaces. The inter-particle spacing was controlled by PEO molecular weights, the incubation time, and the annealing temperatures after incubation. The planar geometry of the PSCs led to Janus NP formation. A series of NP dimers, trimers and tetramers were synthesized. NP nanowires were also fabricated. We anticipate that this observation could lead to controlled synthesis of artificial molecules and NP chains for a variety of optical, electronic, and biomedical applications.