**Microfluidic Synthesis and Surface Engineering of Colloidal Nanoparticles**

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Metal oxide colloidal particles such as silica (SiO$_2$) and titania (TiO$_2$) have many diverse applications ranging from optical displays, catalysis, pigments, and photonic band-gap materials to immunological assays and health-care products. There has also been considerable research interest over the last decade in fabricating core-shell materials with tailored optical, structural, and surface properties. Core-shell particles such as titania-coated silica often exhibit improved physical and chemical properties over their single-component counterparts, and hence, are potentially useful over a broader range of applications. Newer methods of engineering such materials with controlled precision are required to overcome the difficulties with conventional production techniques, which are limited to multi-step batch processes. We have developed microfluidic routes for synthesis, separation, and surface modification of colloidal silica and titania particles. The two chief advantages of a microfluidic particle-engineering platform are: (1) precise control over reactant addition; and (2) mixing and continuous operation. Figure 1 shows a microfluidic chemical reactor for the continuous synthesis of colloidal silica particles [1]. We have also developed a microfluidic device for the electrophoretic separation of charged colloidal particles [2]. Figure 2(a) is a scanning electron micrograph of silica particles synthesized in the micro-reactor of Figure 1, operated in segmented gas-liquid flow mode. Figure 2(b) shows a silica nanoparticle coated with a thick shell of titania. Our ultimate goal is to enable continuous, multi-step colloid processing, with applications including synthesis and surface modification with biological macro-molecules or optical coatings.

**REFERENCES:**
