From CO₂ Capture to Tuneable Optics and Surfactant Self-Assembly: Teaching Anilines New Tricks

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Addressing the challenges facing current society requires creative use of techniques, materials and approaches on the nanoscale and beyond. We have focussed efforts on anilines, looking beyond their well-known conductive properties for solutions to a range of challenges facing the nanosciences and wider society.1

Novel use of modern cross-coupling approaches2 to the synthesis of aniline-based materials allow us to exploit the conjugated N-containing (and thus dopable) backbone structures as well as the tuneable redox and optical properties. Applying such reactions for the formation of conjugated microporous polymers provided routes to efficient and highly selective CO₂ capture,3a with obvious environmental impact and applications. In addition, these materials are showing exceptional I₂ uptake properties,3b with >300 wt% uptake making them promising candidates for application in nuclear waste management.

Using 2-photon polymerisation-based direct laser writing (DLW), finely controlled 3D-printed conjugated structures can be prepared (see Figure 1).4 The ability to print redox-active addressable periodic 3D structures enables the formation of actively tuneable photonic crystals. We show that simple acid-base chemistry enables reversible switching of the refractive index of such structures, with negligible corresponding dimensional change using DLW.

Figure 1. a) 3D-printed responsive photonic structure and b) 3-nm self-assembled nanowires in solution

In further efforts to utilise these functional aniline-based materials, we prepared an oligo(aniline)-based cationic surfactant and investigated its supramolecular organisation into self-assembled nanowires in solution.5 Using the dopable nature of these electroactive tail groups, we can now actively tune their packing parameter, and thus the assembly of these novel electrostatic supram amphiphiles in a reversible fashion. We are currently also exploiting density functional theory (DFT) calculations to provide detailed insight into the optoelectronic properties of our materials,6 and thus enabling further design of species with attractive properties and function.

References: