Micro-patterning and actuation of phosphonium-based photo-responsive ionogels for micro-fluidic applications

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The concept of "Micro-total-analysis-Systems" or "Lab-on-chip" has emerged over the past 20-years but, despite of the fact their incredible potential to revolutionise analytical science few outputs have reached the market so far[1]. Moreover, important issues like durability, disposability and cost of manufacture slow down the process of the integration of micro-fluidics into commercially relevant analytical products[2]. We believe that the next breakthroughs on micro-fluidic technology will come with the development of unconventional strategies in fundamental material science where 'switchable' or 'stimuli-responsive' materials, that can be remotely switched between forms with radically different properties, will substitute conventional fluid handling processes in analytical instrumentation[3].

We present the synthesis, surface patterning and characterisation of micro-valve structures and channel constrictors that underpin further movement towards the realization of next generation micro-fluidic components. The micro-structures are fabricated using novel materials (ionogels) based on phosphonium ionic liquids (ILs), and photo-responsive polymer gels with spiropyran moieties. Actuation can be achieved within seconds and easily controlled without the need for any physical contact between the stimulus source (light) and the resulting action, Figure-1. Furthermore, actuation time can be tuned by simply varying the IL-anion, for instance replacing $[NTf_2]^-$ by $[dca]^-$ without changing the micro-fluidic device.

Figure 1: Microscope images of glass surface patterned phosphonium NTf_2 (left) and dca (right) ionogels before and after white light illumination. Scanning-Electron-Microscopy (SEM) image of NTf_2 ionogel (centre).

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