

## Tunable Nanoparticle and Cell Assembly Using Combined Self-Powered Microfluidics and Microcontact Printing

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The incorporation of nanomaterials in biomedical devices is becoming increasingly common in regenerative medicine, *in vivo* based scaffolds and for the production of organ-on-a-chip type devices. In this context, we designed a device in which we have nano-scale control over the location of inorganic nanoparticles (NP) and proteins on a substrate.

We used a combination of “degas-driven flow” and a microfluidic device to initiate the controlled deposition of different shaped and sized gold NPs on a substrate. This vacuum-soft lithography could be used to produce different NP organisations including nanowires, NP layers, and 3D supercrystals. The morphologies were dictated not only by the mould (a PDMS template) but also by the surface chemistry of the NPs. We combined this technique with microprinting for deposition of biomolecules on, or around, the nanostructures. The approach, named “Printing and Vacuum (PnV) lithography”, allowed a wide choice of type and distribution of NPs and biomolecules.

We used these substrates to show control over the deposition and growth of various human cells, including healthy endothelial and cancerous cells, reacting to both NP supercrystal morphology and biomolecule deposition. Such substrates were non-toxic and cells remained viable over days. Various methods could be used to “view” the processes occurring from the initial NP deposition on the substrate (darkfield microscopy) to cell interactions with underlying biomolecules (surface enhanced Raman spectroscopy), and individual cell:NP connections (SEM). We obtained preliminary results in the use of plasmonic gold NPs to induce local heating and manipulation of cell adhesion.

In conclusion, we present a novel multicomponent patterning technique which can act as a biocompatible substrate for controlled cell morphology and function.

