3D-Printed Soft Active Matter

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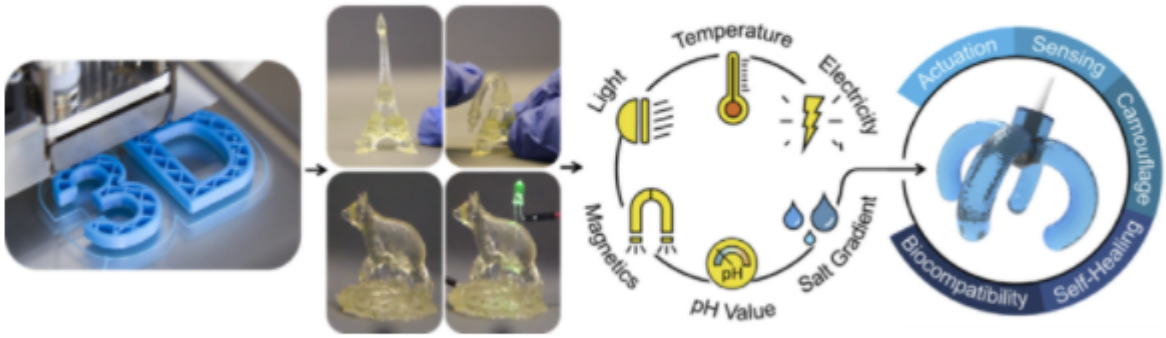
Slowly yet steadily, additive manufacturing technologies have become a major player in the fabrication of polymeric devices with controlled architectures such as personalized prototypes, soft electronics, sensors and actuators as well as tissue and biomedical engineering. Based on a layer by layer fabrication, with resolution in the range of micro- to nanometers per layer, the computer-assisted printing significantly speeds up the development of custom 3D devices without actually inflating the costs. Despite the irrefutable progress made around 3D printing, the technique still suffers from rigid and static properties of the printed parts and lack of fabrication approaches controlling the material anisotropy. In light of these limitations, a breakthrough strategy towards designing anisotropy-encoded structures using commercial stereolithography technology is reported by means of controlling either the specific surface area to volume ratio, the crosslinking density or the chemical composition of discrete layers during fabrication. The key element here is the time, where the actuation, the sensing and the programmability are directly embedded into the material structure and occur in desired time frames. The latest efforts along these lines involve a family of 3D-printed materials including (1) multi-responsive functionally graded hydrogel-based actuators capable of rapid, controllable motion in response to environmental parameters, (2) self-powered iontronic touch sensors which utilize touch-induced ionic charge separation in ionically conductive hydrogels, (3) structurally-colored composite elastomer exhibiting a stress-dependent color change and high toughness using submicron-sized silica particles and arranging them in a periodic structure in the elastomer, (4) phenylboronic acid-containing implants with on-demand glucose-triggered drug release abilities for personalized medicine, and (5) cell-laden gelatin-based hydrogels of enhanced cell viability and biological functionality. This work represents a flexible platform for designing more advanced 3D-printed polymeric materials beyond the present studies that would promote new potential applications.



Biography

Jérémy Odent (2 patents, 46 papers, h-index = 18, 940+ citations, ORCID ID 0000-0002-3038-846X) is an associated professor at University of Mons (UMONS, Belgium) and a member of the Laboratory of Polymeric and Composite Materials (LPCM) which is internationally recognized for (1) the synthesis of polymers of tailored and well controlled molecular structures, and (2) the production of (nano)filled polymers and/or (nano)filled polymer blends by (reactive) melt processing, reactive bulk impregnation, (nano)particle functionalization, grafting and encapsulation. His research involves the development of advanced polymeric materials and nanocomposites with desired properties and boosted functionalities as well as the possibilities offered by advanced additive manufacturing technologies to meet the ever-increasing demand of complex device platforms. Among his recent investigations, the combination of ionic hydrogel composites and additive manufacturing technology has shown great promise as a means of generating parts with novel functionality. He also designed new 3D-printed polymeric inks capable of forming tough structural elements and providing novel electrical and optical functionalities for sensing and soft robotic applications.