A PDMS-Acrylate Resin for Stereolithographic 3D-Printing of PDMS

This technology offers an automated 3D fabrication of PDMS-acrylate resin for custom microfluidics. This development could be used for high-throughput and autonomous microfluidics, soft-robotics, point-of-care diagnostics, implantable microdevices, tissue engineering and organ-on-a-chip systems.

Technology ID

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Category

Materials/Other
Selection of Available Technologies

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What is the Problem?

Microfluidics has had a great impact in a broad range of areas, from biological analysis and basic cell biology to chemical synthesis or optics. Microfluidic systems are usually built by replica-molding and bonding in elastomers, such as PDMS or thermoplastics, such as PMMA or polystyrene. These polymers owe their success to four key properties: biocompatibility, transparency, low cost, and being copyright-free. PDMS, in addition, is also elastomeric—a property that is key for producing fluidic automation components—and gas-permeable—a key factor for allowing O2 and CO2 exchange in cell culture applications. Although applications are not lacking and PDMS molding is able to produce micron-resolution features, PDMS mold fabrication requires a lengthy manual procedure. Furthermore, complex devices need to be fabricated by layering, which severely restricts the possible 3D geometries. In order to be cost-effective, molded devices have to be produced in large numbers, require large initial capital investments, and they cannot be customized in short time frames. An alternative rapid plastic fabrication method allowing for more complex geometries and multi-height structures that are not limited to layers is micromilling; however, micromilling still requires assembly and bonding to produce closed channels, and the milling tool cannot cut arbitrary shapes. Stereolithography 3D printing has recently attracted attention for custom-fabricated complex microfluidic systems for research and development due to its automated 3D fabrication, rapidly decreasing costs, and improving resolution. However, available stereolithography resins do not have all the favorable physicochemical properties of the above-named polymers. A need exists to improve stereolithography 3D-printing methods to provide PDMS SL 3D-printed structures.

What is the Solution?

The solution is a new formulation of a PDMS-acrylate resin for 3D-printing elastomeric structures at high resolution using UV based stereolithography. When printed, this elastomeric PDMS is optically transparent and can be made with mechanical properties similar to thermally cured PDMS, which has been extensively used for a wide variety of applications. This enables printing of enclosed microchannels with sub-millimeter resolution with assembly-free fabrication of microfluidic devices. This could be used for high-throughput and autonomous microfluidics, soft-robotics, point-of-care diagnostics, implantable microdevices, tissue

engineering and organ-on-a-chip systems.

What is the Competitive Advantage?

Existing microfluidic systems require large production and a large initial investment, while being limited in 3D geometries. Existing stereolithography resins do not have the desired physicochemical properties of thermally cured PDMS. This system allows for the custom fabrication of complex microfluidic systems for research and development due to its automated 3D fabrication, rapidly decreasing costs, and improving resolution, while also having the desired physiochemical properties of biocompatibility, transparency, elasticity, and gas permeability.

Patent Information:

US11104802B2

References

1. Dr. Nirveek Bhattacharjee, Dr. Cesar Parra-Cabrera, Dr. Yong Tae Kim, Alexandra Kuo, and Prof. Albert Folch(43191) , https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6286193/, Adv Materials