Researchers develop reprocessable thermosets for sustainable 3-D printing

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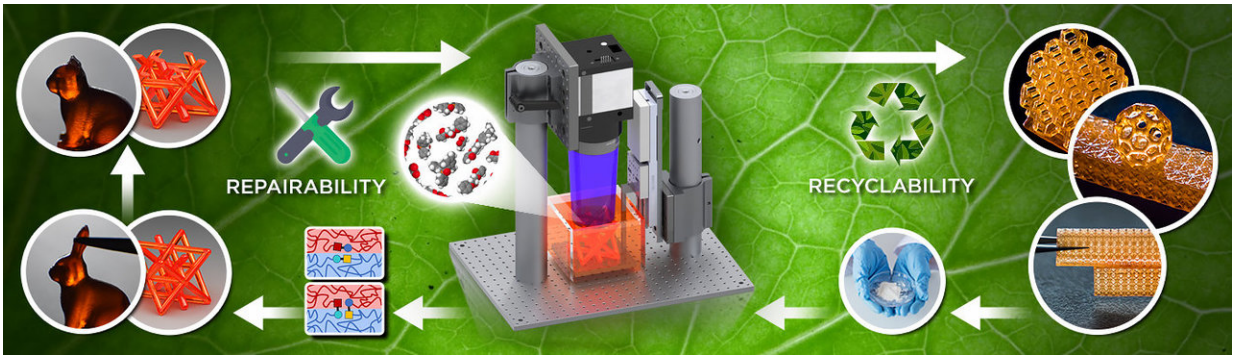

3D printing reprocessable thermosets (3DPRTs) make 3D printed structures reshapeable, repairable and recyclable. Credit: Kavin Kowsari

3-D printing of complex structures that contain submillimeter-sized features has eluded researchers for decades. Recent advancements in 3-D printing have brought about viable 3-D printing techniques such as digital light processing (DLP)-based systems that use ultra-violet (UV) light to transform initially-liquid polymer resins into free-standing solid structures in a precise, controlled manner.

Among all 3-D printing materials, thermosetting photopolymers claim almost half of the market due to their superior mechanical stability at high temperatures, excellent chemical resistance, and good compatibility with high-resolution 3-D printing technologies. However, once these

thermosetting photopolymers form 3-D parts through a UV-triggered chemical reaction, the covalent networks are permanent and cannot be reprocessed, i.e., reshaped, repaired or recycled. This unprocessable nature, combined with the explosion in 3-D printing globally, is leading to vast waste of 3-D printing materials with serious environmental implications

To address this environmental challenge, researchers from the Singapore University of Technology and Design (SUTD) have developed 3-D printing 'reprocessable' thermosets (3DPRTs) that make 3-D printed structures reshapeable, repairable and recyclable.

"We have developed, for the first time, reprocessable thermosetting photopolymers designed for DLP-based high-resolution 3-D printing," said Assistant Professor Qi (Kevin) Ge from SUTD's Science and Math Cluster, one of the co-leaders of this project. He added, "Firstly, high-resolution structures can be reformed and fixed into arbitrary shapes subsequent to printing. This attribute improves printing efficiency as, for instance, 3-D origami parts can be generated from flat, 2-D layers. Secondly, the structure is repairable, meaning that damaged sites can be reprinted while perfectly maintaining structural integrity, prolonging product durability. Third and most importantly, our material can be recycled and reused for other applications."

"Overall, we believe the development of 3DPRTs provides a practical solution to address environmental challenges associated with the ongoing rapid increase in the consumption of 3-D printing materials which are increasingly being utilized in a broad range of advanced applications including tissue engineering, soft robotics, nano-devices and many others," said Professor Martin Dunn, the other co-leader of this project, and currently Dean of College of Engineering and Applied Science at the University of Colorado Denver.

Details of this work appeared in *Nature Communications* on 8 May 2018.

More information: Biao Zhang et al, Reprocessable thermosets for sustainable three-dimensional printing, *Nature Communications* (2018). DOI: 10.1038/s41467-018-04292-8