Micro-Lisa: Making a mark with novel nano-scale laser writing

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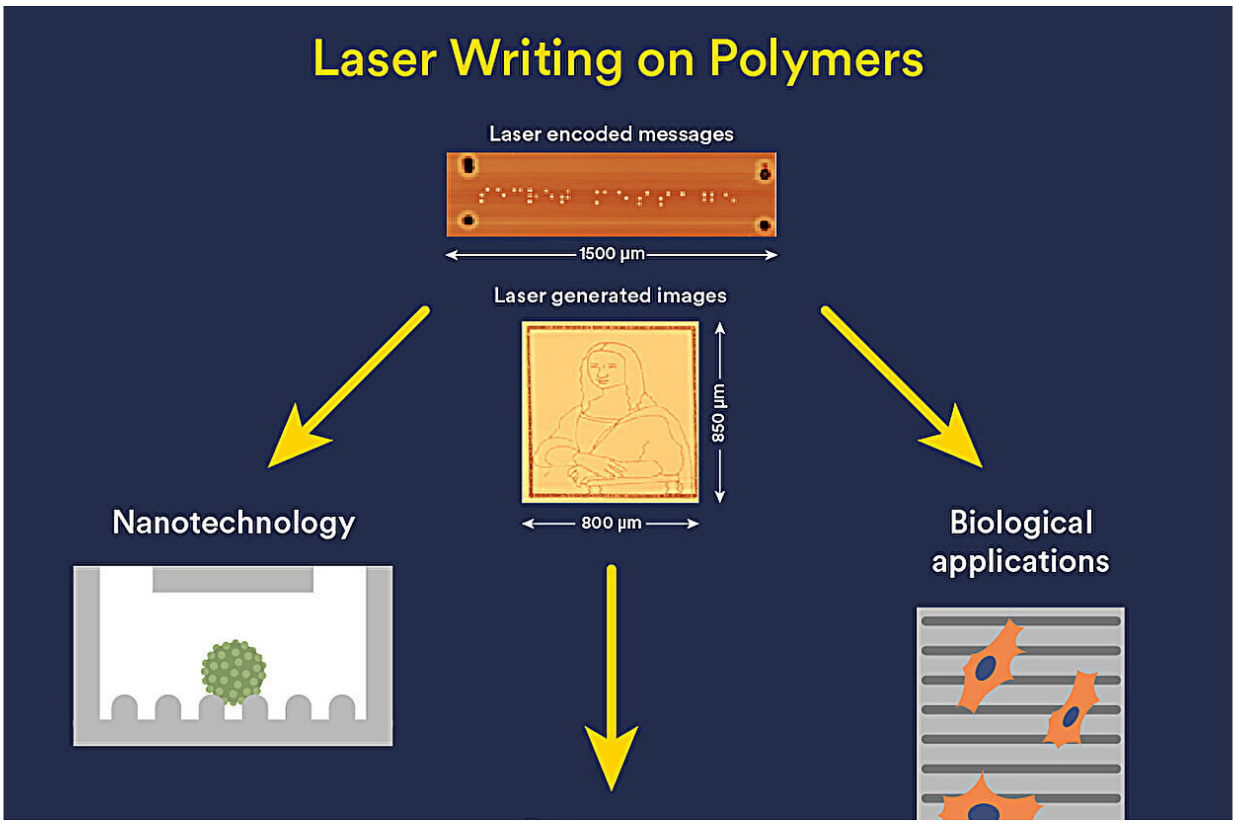


Potential applications include new approaches to storing data on polymers, new patterned surfaces for biomedical applications, and new ways to make micro- and nanoscale devices for electronics, sensors and microfluidics. Credit: Flinders University

High-power lasers are often used to modify polymer surfaces to make high-tech biomedical products, electronics and data storage components.

Now Flinders University researchers have discovered a light-responsive, inexpensive sulfur-derived polymer receptive to low power, visible light lasers—which promises a more affordable and safer production method in nanotech, chemical science and patterning surfaces in biological applications.

Details of the novel system have just been published in *Angewandte Chemie International Edition,* featuring a laser-etched version of the famous "Mona Lisa" painting and micro-Braille printing even smaller than a pin head.

"This could be a way to reduce the need for expensive, specialized equipment, including high-power lasers with hazardous radiation risk, while also using more sustainable materials. For instance, the key polymer is made from low-cost elemental sulfur, an industrial byproduct, and either cyclopentadiene or dicyclopentadiene," says Matthew Flinders Professor of Chemistry Justin Chalker, from the Flinders University.

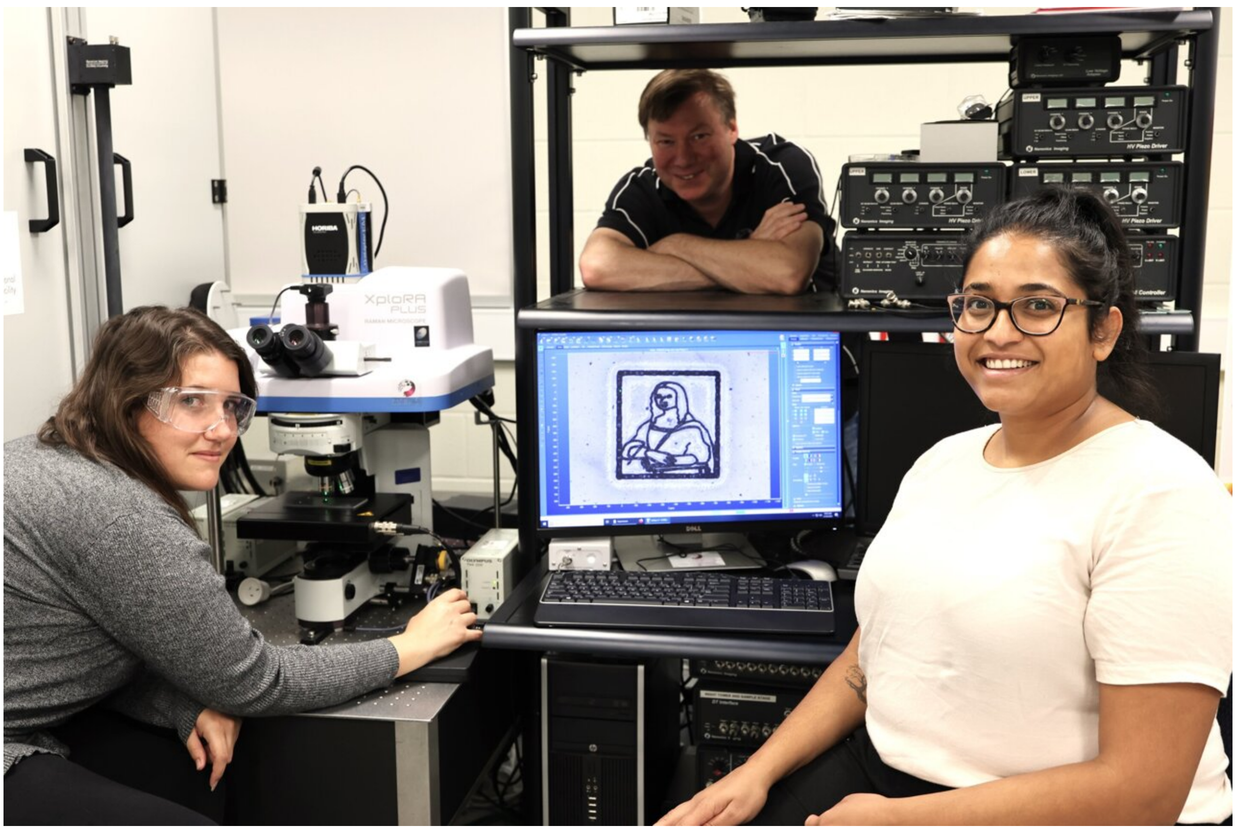
"Our study used a suite of lasers with discreet wavelengths (532, 638 and 786 nm) and powers to demonstrate a variety of surface modifications on the special polymers, including controlled swelling or etching via ablation. The facile synthesis and laser modification of these photo-sensitive polymer systems were exploited in applications such as direct-write laser lithography and erasable information storage," says Dr. Chalker, from the Flinders University Institute for NanoScale Science and Engineering.

As soon as the laser light touches the surface, the polymer will swell or etch a pit to fashion lines, holes, spikes and channels instantly.

The discovery was made by Flinders University researcher and co-author

Dr. Christopher Gibson during what was thought to be a routine analysis of a polymer first invented in the Chalker Lab in 2022 by Ph.D. candidate Samuel Tonkin and Professor Chalker.

Dr. Gibson says, "The novel polymer was immediately modified by a low-power lasers—an unusual response I had never observed before on any other common polymers. We immediately released that this phenomenon might be useful in a number of applications, so we [built] a research project around the discovery."



First author Ph.D. candidate Ms Abigail Mann next to the low-power laser, left, ANFF spectroscopist Dr. Jason Gascooke and Dr. Lynn Lisboa with the 'micro-Lisa' laser image displayed on a regular computer screen. Credit: Flinders University

Senior Flinders University researcher Dr. Christopher Gibson discovered that a new polymer invented in the Chalker Lab in 2022 could be immediately modified by a visible low-powered laser light. Credit: Flinders University

Another Flinders College of Science and Engineering Ph.D. candidate, Abigail Mann, led the next stage of the project and is first author on the journal paper.

"The outcome of these efforts is a new technology for generating precise patterns on the polymer surface," she says. "It is exciting to develop and bring new microfabrication techniques to sulfur-based materials. We hope to inspire a broad range of real-world applications in our lab and beyond."

Potential applications include new approaches to storing data on polymers, new patterned surfaces for biomedical applications, and new ways to make micro- and nanoscale devices for electronics, sensors and microfluidics.

With support from research associate Dr. Lynn Lisboa and Samuel Tonkin, the Flinders team conducted detailed analysis of how the laser modifies the polymer and how to control the type and size of modification.

Dr. Lisboa adds, "The impact of this discovery extends far beyond the laboratory, with potential use in biomedical devices, electronics, information storage, microfluidics, and many other functional material applications.

Flinders spectroscopist Dr. Jason Gascooke, of the Australian National Fabrication Facility (ANFF), also worked on the project.

More information: Abigail Mann et al, Modification of Polysulfide Surfaces with Low-Power Lasers, *Angewandte Chemie International Edition* (2024). DOI: 10.1002/anie.202404802

Provided by Flinders University

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