Printable holograms could make holograms more widespread

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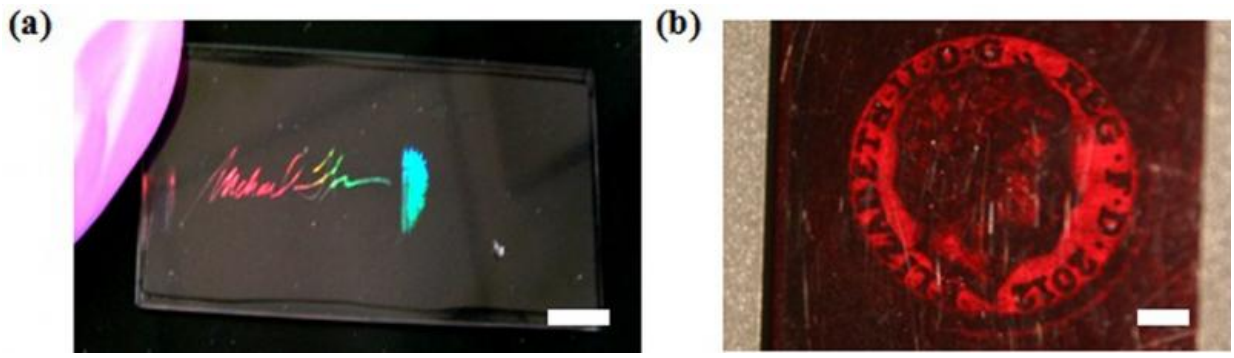

(a) A 2D ink-based holographic signature and (b) a 3D holographic coin, both recorded by single nanosecond-laser interference. Credit: Zhao, et al. ©2015 AIP Publishing

(Phys.org)—Holograms have a wide variety of applications, from 3D displays to data storage, but the potential applications are currently limited by the complexity and cost of hologram fabrication. In an attempt to simplify the hologram fabrication process, scientists have developed a way to print holograms using a relatively simple and inexpensive laser-printing technique. They hope that the new method will make hologram fabrication more accessible for small-scale and personal use, opening up new types of applications such as integration with smart phones.

The researchers, led by Dr. Haider Butt at the University of Birmingham, have published a paper on the printable holograms in a recent issue of *Applied Physics Letters*.

As the researchers explain in their paper, traditional holography fabrication requires specialized knowledge, expensive equipment, and time-consuming recording techniques. Recently, scientists have developed an alternative technique that uses a laser pulse that is split into two beams to create an interference pattern on a surface, producing the characteristic 3D holographic pattern. However, this approach has its own challenges, as it requires precise alignment of the two laser beams and suffers from low light intensity after beam splitting.

In the new paper, the researchers have overcome these challenges by developing a single-pulse laser technique that can rapidly print 2D and 3D holograms in seconds on flat or curved surfaces and on a variety of materials. The nanosecond laser can print 1 cm^2 of hologram area in just 5 nanoseconds. The researchers explain that the overall speed is not limited by the laser pulse, but by the need to reposition the surface in between lasing, which could potentially be done much faster using robotics.

"The technique is slightly different from the conventional methods, which divide a single pulsed beam using beam splitters and then recombine them to produce holograms and nanopatterns," Butt told *Phys.org*. "Here we use only a single beam, which is reflected normally from a mirror. The incident and reflected beams interfere, and this interference pattern is used for writing/printing holograms. The technique requires far fewer optical components, it is very simple, reliable, and can be used for ablating a myriad of materials and substrates."

The scientists demonstrated the new technique by printing a holographic

2D signature and a holographic 3D coin. They expect that the method could be especially useful for printing holograms on sensors and "smart" materials that change in response to various stimuli. Printable holograms could also be integrated into smart phones, where, as the researchers explain, they can be used to interpret colorimetric data in pictures.

"The holograms printed with this method can be printed using dynamic materials, which are able to respond to any stimuli in their environments," Butt said. "And they will change their color in response to any environmental changes. Using smart phone cameras and applications, such colorimetric changes can be read, interpreted, and communicated remotely."

Additional applications may include 3D artwork, smart windows, and bio-sensing, among others.

"This work can lead to further applications, such as holographic data storage, optical sensors, and printable optical devices," Butt said. "We and our collaborators are currently pursuing all these research paths and achieving good results."

More information: Qiancheng Zhao, et al. "Printable ink holograms." *Applied Physics Letters*. DOI: 10.1063/1.4928046

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