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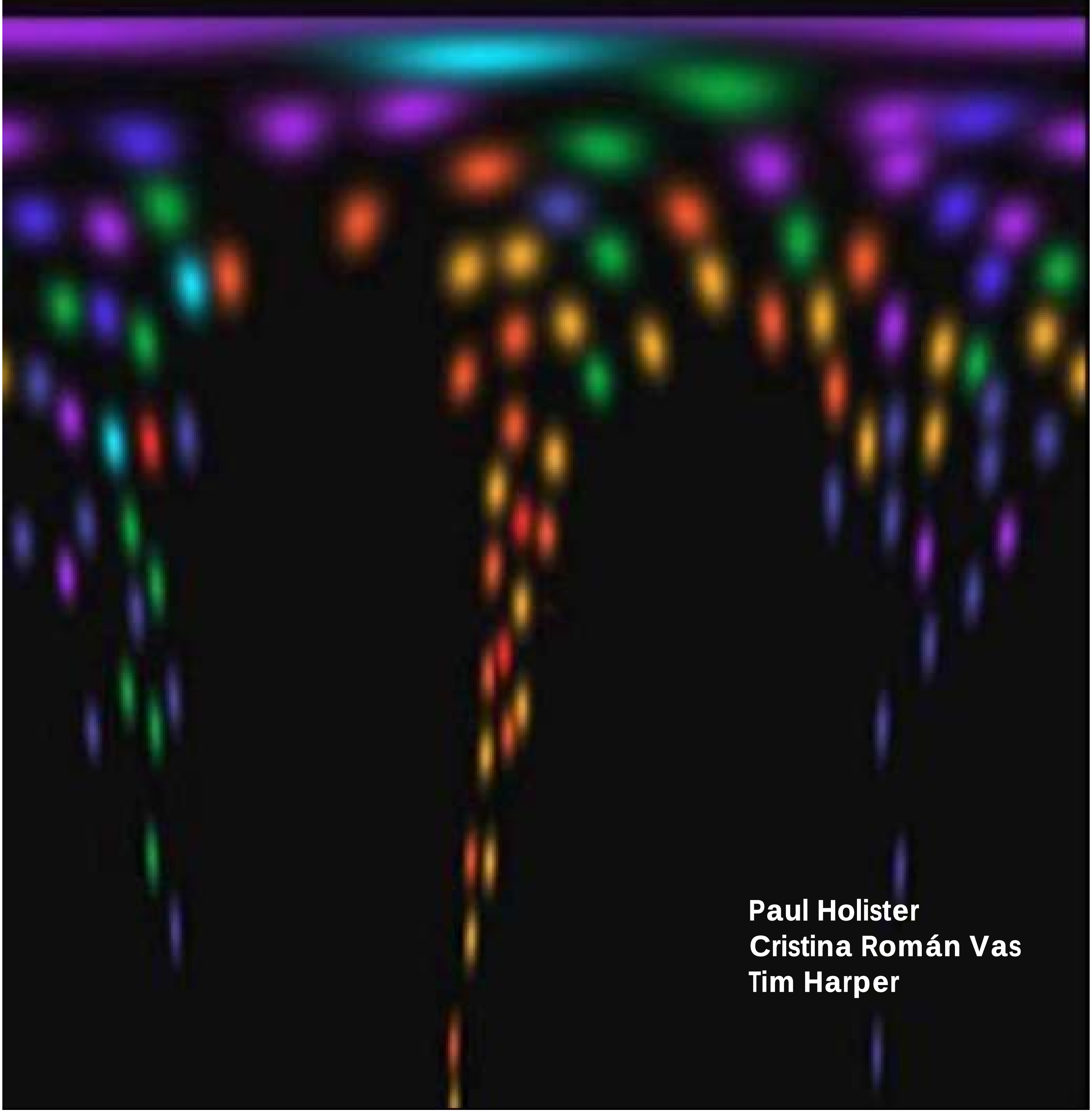
Nanoprinting

Technology White Papers
nr. 11



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Origin of content

The free reports in this series are extracted from the technology reports that make up the Nanotechnology Opportunity Report collection and are designed to offer an introduction to the variety of technologies that fall under the nanotechnology umbrella. The full reports also include 'opportunities' sections, covering the various applications of the technology and their effects on markets, and a list describing the companies involved in the technology.

Soft lithography (nanoprinting)

Introduction to soft lithography

Soft lithography is a collection of techniques based around micro or nanostructured forms used as molds. The rise of nanoimprinting techniques has led to a reduction in the use of the term soft lithography, especially since the 'soft' aspect is not always present. Nanoprinting thus serves as a more useful general term when feature sizes are nanoscale, but should be considered interchangeable (soft lithography will continue to be used here since many current applications are not yet nanoscale). The three main approaches are:

- Stamping. Pressure is used to make an impression of a mold in a surface.
- Inking. The mold is coated with an "ink", which is then transferred to a surface on application of the mold. Also known as microcontact printing.
- Capillary. A mold is placed on a surface and a liquid polymer flows by capillary action into the spaces formed between the surface and relief pattern on the mold. Often called microinjection molding in capillaries (MIMIC).

No special technology is required, and nor are the ultra-clean environments required for existing silicon chip production. Additionally, a wide variety of materials can be used. The approach is reminiscent of one of the most famous examples of mass production, the printing press.

Soft lithography scales readily down to the nanoscale (depending on the variant of the technology used, resolution can get below 10 nanometers—molecular-scale nanostructures have already been created in the laboratory). The techniques also promise potential in the creation of optical devices, which may in turn ultimately be used in optical computing. As a replacement for traditional lithography for creating electronic devices, however, there is currently a major obstacle—the technique is not well suited to making the precisely-aligned, multi-layered structures currently used in microelectronics, although researchers are working to overcome this limitation. In this area there is promise for an approach based on the capillary technique that is used by a group at the University of Austin in Texas, led by Grant Willson (they have even spun out a company, Molecular Imprints). The main issue here is accurate control over the alignment. Additionally, for stamping techniques, there is the problem of evenly applying pressure once the mold goes above a minimum size. This is not the case with the inking approach (microcontact printing), but here diffusion of the ink can blur the edge of lines. Note that the inking approach often uses substances that form self-assembled monolayers.