Fab new laser nano-fabrication technology

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(PhysOrg.com) -- Laser interference lithography can produce very high-resolution nano-scale surface patterns at low cost, and now European researchers have made important breakthroughs in the area.

Two important breakthroughs by European researchers have brought an emerging nano-scale fabrication technology out of the lab and into the real world. The technique promises lower cost production of nano-devices at higher resolutions.

It will mean better and cheaper production methods for such things as self-cleaning materials, nano-sensors and gratings, nano-filters for clean air and water and special anti-reflection surfaces for solar technology.

Interference lithography is a surface patterning technique that has generated enormous interest in labs across the world. But the DELILA project took it out of the lab and proved the technique could work on a commercial scale, all the while achieving world-class breakthroughs. The technology will be helping to create the next wave of nanotechnology in two to three years.

Precise interference

Laser interference lithography creates surface patterns by splitting a coherent beam of light, say a laser beam, and then recombining the light very precisely, so that the split beams cross and create patterns of interference. Added together, these patterns produce a surface pattern on material, which can then be processed in the normal manner.

Interference lithography is attractive because it allows the fast generation of dense features over a wide area without loss of focus. It is also costs less to build these production lines because they do not require complex optical technology or photomasks.

The savings are very significant. Where typical fabrication systems cost in the millions of euros, systems based on DELILA's breakthroughs would cost just in the hundreds of thousands.

Dominant technology

"It is known that nanotechnology will play a dominant role in this century in almost all the scientific and industrial areas for development of new materials, devices and systems," points out Zuobin Wang, coordinator of the DELILA project and a senior research fellow at the University of Cardiff's Manufacturing Engineering Centre (MEC). "However, the key problem remains the lack of low cost and volume manufacturing technologies and systems."

“We focused on the development of a new production technology for fabricating 2D and 3D nano-structures and devices, laser interference lithography. In particular, DELILA will enable low-cost and large-volume production of nano surface structures and patterns.”

DELILA stands for Development of Lithography Technology for Nanoscale Structuring of Materials Using Laser Beam Interference. In addition to being cheap, this method can print 2D and 3D nano-structures. It makes it perfect for nano-photonic and nano-electronic devices and micro and nano-fluidic devices.

Nano-fluidics is a field of nanotechnology that looks at the behaviour of fluids at extremely small dimensions - acting in a manner that can be manipulated predictably. It has many applications in manufacturing where fluids are involved, such as testing tiny samples of a drug, for example. The field is still in its infancy but already it is having an enormous impact. DELILA will give it a new tool.

Broad front

The team attacked the problem on a broad front, looking at everything from the technological potential of multiple beam interference to user needs. The main focus of the work, however, was in building a viable production prototype.

Here the problem was integrating the various elements within the system and then perfecting each element. A key breakthrough occurred with the tuning part of the work, manipulating light to create the interference in the patterns and at the scales required.

DELILA showed for the first time feature sizes of ~30nm for direct writing and ~5nm for modification of nano-structures. These are state-of-the-art results for the technology.

Direct writing is where laser beam interference etches patterns directly onto a die, without using a photomask. It is much cheaper than standard processes for achieving the required features. The 30nm result refers to the systems capacity to create precise feature sizes in the desired pattern.

The structure modification result, however, is in many ways more interesting. This is the smallest possible structure that the system can achieve right now. It is currently not sufficiently precise for commercial application, but the fact that DELILA was able to achieve any modification at this scale indicates that it will be possible to achieve the required precision for commercial purposes. This will be the next research goal.

Patently busy

The team had a busy schedule during the project. In addition to producing the breakthrough results, the team submitted five patent applications and more than 20 technical publications, many more than were expected.

Aspects of their work have direct market relevance now, with commercial products based on DELILA's results slated to start fabricating real devices in the next two to three years.

Perhaps even more exciting, however, is the prospect of much greater advances in the technology in the near future.

Remember, DELILA achieved structures of just 5nm using the technology. Although this result is also not yet commercially ready, Wang believes the team can achieve commercial 5nm direct writing with laser interference lithography in the next five years.

More information: DELILA project - www.delila.cf.ac.uk/

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