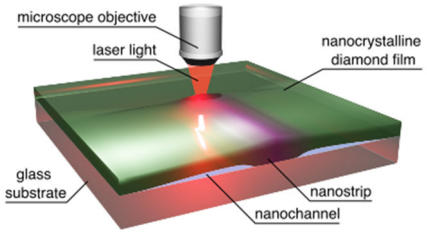
OIST | Innovation

Rapid laser writing of diamond-glass nanochannels

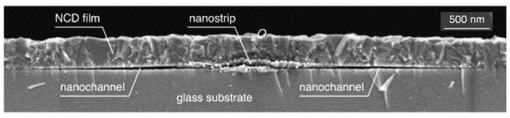
Summary

Glass nanofluidic devices are an emerging class of promising tools for applications such as single biomolecule analysis, nanoreactors and MEMS/NEMS. However, nanoscale processing is challenging, costly, and time-consuming.

Researchers in OIST's Mechanics and Materials Unit have developed a novel, inexpensive method to fabricate highly durable diamond-glass nanochannels by direct laser writing on a nanocrystalline diamond (NCD)-glass substrate. This fabrication method is extremely rapid (200 mm/s) and does not require a cleanroom. Further functionalities are in the process of being demonstrated, including writing of non-linear patterns, creating intersections, and writing rectangular channels.



Rapid, direct laser writing on an NCD-glass substrate forms a pair of nanochannels on either side of a central "nanostrip"



SEM image of the nanochannels' cross-section, through which liquids can flow by capillarity

Technology

NCD films can be readily grown on large-area glass substrates by microwave plasma-assisted chemical vapor deposition using a precursor mixture of methane and hydrogen, after depositing inexpensive nanodiamonds. Nanochannels can be formed by direct writing onto the NCD film using a standard femtosecond laser. The laser writing induces sample expansion near the film–substrate interface, transforming the lasered portion into a "nanostrip" consisting of NCD, non-diamond carbon, and glass particles. In the process, two nanochannels are formed on either side of the nanostrip by controlled delamination of the NCD film. The mean height and width of the formed nanochannels are in the order of 30 nm and 2 μm, respectively, and can be tuned by adjusting the laser power. Using reflected light microscopy and confocal laser scanning microscopy, the research team also demonstrated that water flows through the nanochannels by capillary action.

Applications

- Nanofluidic devices
- Nanoreactors
- Single biomolecule analysis
- Nano-vents for electronics packaging

Advantages

- Extremely rapid and low-cost
- High transparency and durability
- No sealing step needed
- Does not require a clean room

Category
Chemistry & Materials Science

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Intellectual Property
Patent Pending

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