Three dimensional silicon micromachining using a nuclear microprobe

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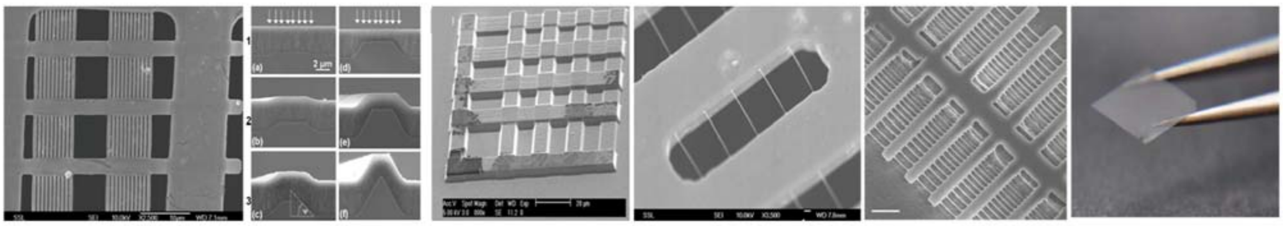
At CIBA we have developed a process for fabricating 2 & 3D silicon and porous silicon components. This process is described and its uses in optics, photonics, microfluidics and nanoscale surface patterning are reviewed. The process is based on high-energy ion irradiation, with typically from 50 keV to 1 MeV protons and helium ions. The defects introduced by irradiation alter the hole current flow during subsequent electrochemical anodization, allowing the anodization rate to be slowed or stopped for low/high fluences. For moderate fluences the anodization rate is selectively stopped only at depths corresponding to the high defect density at the end-of-range, allowing three-dimensional silicon machining.
By combining different ion energies and fluences within the same area, we have created free-standing, large-area silicon nanostencils with feature sizes down to 50 nm. This equals to the minimum feature sizes which can be produced in conventional silicon nitride stencils and our capability to make nanostencils in thicker, stress-free crystalline silicon provides a new means of nanoscale patterning of many types of substrates.
In another recent development of this process we have shown that low fluence irradiation can actually result in highly porous end-of-range regions. These zones can be selectively removed, leaving buried, hollow lines in porous silicon. After high temperature oxidation the remaining porous silicon forms a solid volume of glass, leaving the hollow micro/nano-scale channel buried beneath the surface. This new method of producing buried nanochannels in glass is being applied to DNA flow studies.



Examples of 2 & 3D machined structures

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