Incorporation of micro- and nano-scale porosity on silicon surfaces

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We report on the formation of porosity in the micro- and nano-scale dimensions on a silicon surface. Our method involves formation of a polymeric layer with micro- and nano-scale dimension through-pores having an interconnected structure, as an etch mask on a silicon surface. The interconnected pores of the porous polymer layer allow an appropriate chemical etchant to access the underlying silicon and etch it, resulting in the controlled formation of pores in silicon. The porosity in the polymer mask layer will influence the porosity in silicon. In comparison to other methods involving the direct etching of silicon in a suitable chemical etching solution, the use of a porous polymer etch mask allows the controlled incorporation of porosity on a silicon surface, especially with regards to pore density, lateral and depth dimensions of pores, among others. The porous polymer is formed by spin-coating a wet layer of silicone elastomer incorporated with poly vinylidene flouride (PVDF). Following the curing of the silicone, the PVDF is removed by an ultrasonic bath of acetone, leaving behind pores in the silicone. The extent of porosity in silicone is determined by the extent of doping with PVDF. The areas where porosity is not desired are coated by a non-porous polymer patterned by UV lithography. Porosity is incorporated in the desired areas of a silicon surface by placing it in a suitable chemical etch solution. Subsequently, the porous and non-porous polymer layers are detached from the silicon surface. The present method is an alternative to other methods of forming porosity on silicon such as anodizing, and photosynthesis-based etching. The method described in this abstract can be applied to make porous silicon for applications in opto-electronic devices and systems, biomedical applications involving immobilization of molecules of biochemicals, proteins, enzymes on silicon, and bio-sensing applications involving surface-enhanced or simple Raman spectroscopy.