

P-형 실리콘에서 마이크로 와이어 형성에 미치는 마스크 패턴의 영향

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The Effect of Mask Patterns on Microwire Formation in p-type Silicon

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Abstract : The electrochemical etching of silicon in HF-based solutions is known to form various types of porous structures. Porous structures are generally classified into three categories according to pore sizes: micropore (below 2 nm in size), mesopore (2 ~ 50 nm), and macropore (above 50 nm). Recently, the formation of macropores has attracted increasing interest because of their promising characteristics for a wide scope of applications such as microelectromechanical systems (MEMS), chemical sensors, biotechnology, photonic crystals, and photovoltaic application. One of the promising applications of macropores is in the field of MEMS. Anisotropic etching is essential step for fabrication of MEMS. Conventional wet etching has advantages such as low processing cost and high throughput, but it is unsuitable to fabricate high-aspect-ratio structures with vertical sidewalls due to its inherent etching characteristics along certain crystal orientations. Reactive ion dry etching is another technique of anisotropic etching. This has excellent ability to fabricate high-aspect-ratio structures with vertical sidewalls and high accuracy. However, its high processing cost is one of the bottlenecks for widely successful commercialization of MEMS. In contrast, by using electrochemical etching method together with pre-patterning by lithographic step, regular macropore arrays with very high-aspect-ratio up to 250 can be obtained. The formed macropores have very smooth surface and side, unlike deep reactive ion etching where surfaces are damaged and wavy.

Especially, to make vertical microwire or nanowire arrays (aspect ratio = over 1:100) on silicon wafer with top-down photolithography, it is very difficult to fabricate them with conventional dry etching. The electrochemical etching is the most proper candidate to do it. The pillar structures are demonstrated for n-type silicon and the formation mechanism is well explained, while such a experimental results are few for p-type silicon.

In this report, In order to understand the roles played by the kinds of etching solution and mask patterns in the formation of microwire arrays, we have undertaken a systematic study of the solvent effects in mixtures of HF, dimethyl sulfoxide (DMSO), iso-propanol, and mixtures of HF with water on the structure formation on monocrystalline p-type silicon with a resistivity with 10 ~ 20 $\Omega \cdot \text{cm}$. The different morphological results are presented according to mask patterns and etching solutions.

Key Words : p-type Si, microwire, electrochemical etching