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Electron localization in SrTiO$_{3-\delta}$ thin films

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Strontium titanate is a typical perovskite oxide with a wide range of electrical properties upon various doping. Various dopants suchas La, Nb, and oxygen vacancies lead to the change from insulator to an n-type semiconductor and finally to a metallic behavior. Among them, the self-doping by oxygen vacancies is essential since the oxygen vacancy is one of the fundamental and intrinsic defects in perovskite oxides and gives a critical impact on their properties, such as magneto-resistance and super conductivity. In our previous study, we report that oxygen vacancies in SrTiO$_{3-\delta}$ tend to order in a linear way. Simultaneously, electrical conduction decreases via electron localization. In this study, we verified oxygen vacancy clustering and electron localization in SrTiO$_{3-\delta}$ thin films by measuring transport properties and electronic structure. In the result, we found the reduction of the carrier density of annealed SrTiO$_{3-\delta}$ thin films at below 400℃. The photoemission spectroscopy (PES) result showed that electrons are localized at defect states in band gap. The defect states are generated by the oxygen vacancy leading to the Ti oxidation state Ti(II). The corresponding electronic configuration of defect state is Ti 3d2, which is good agreement with the localization state in our previous study. This phenomenon is understood by oxygen vacancy clustering and electron localization.

Keywords: SrTiO3, oxygen vacancy, clustering

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Si Nano needle 제작을 위한 유도결합 플라즈마 etching 공정개발

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현재 nano needle 기술은 STM(Scanning tunneling microscope) tip, AFM(Atomic Force Microscope) probe tip, non-stick surface를 얻기 위한 super-hydrophobic, SPM(Scanning Probe Microscope)용 nano-needle 탐침, nanowell array chip등 측정장비 및 Bio-MEMS(Micro Electro Mechanical Systems) 분야에 다양하게 적용되고 있다.

ICP(Inductively Coupled Plasma)를 이용한 Si Nano-needle structure는 기존의Wet etching이나 RIE(Reactive Ion Etching) 방식에 비해 Shape이 우수하며, 원하는 크기의 미세 구조물을 형성하는데 용이하다.

본 연구에서는 Plasma에 의한 미세 구조물의 손상을 막기 위해 적절한 Coil Power, Bias Power, Gas flow rate, Pressure 등을 조절하여 100nm이하의 Si nano-needle 제작을 위한 etching 공정조건을 확립하였다. Si etching을 통한 nano-needle 을 형성하기 위해 6 inch Si(100) wafer를 사용하였으며, 선택적인 Si etching을 위한 buffer layer로 PE-CVD (Plasma Enhanced Chemical Vapor Deposition)를 이용하여 Si 위에 1000Å SiO2를 증착 시켰다. Si etching을 위한 buffer layer를 patterning한 후, dry etcher (ICP System, STS, England)를 사용하여 Si etching을 실시하였으며, 최종 HF(10:1) 처리로 residual oxide를 제거함으로써, Si nano-needle structure를 형성할 수 있었다. 형성된structure의 표면상태(Surface Morphology), 식각률(Etch Rate), SiNano-needle의 형상 등을 분석하기 위하여 FE-SEM (Field Emission Scanning Electron Microscopy)을 사용하였다.

본 연구를 통한 nano-needle의 제작 공정은 앞으로 Nano imprint Lithography(NIL)용 stamp, 바이오 분야의 nanowell array chip 등에 크게 활용될 것이라 전망된다.

Keywords: Inductively Coupled Plasma(ICP), Si Etching, Nano needle