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Layer-by-layer Control of MoS2 Thickness by ALET

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Molybdenum disulfide (MoS2)는 van der Waals 결합을 통한 층상구조의 물질로써 뛰어난 물리화학적, 기계적 특성으로 Field Effect Transistors (FETs), Photoluminescence, Photo Detectors, Light Emitters 등의 많은 분야에서 연구가 보고 되어지고 있는 차세대 2D-materials이다. 이처럼 MoS2 가 다양한 범위에 응용될수 있는 이유는 layer 수가 증가함에 따라 1.8 eV의 direct band gap 에서 1.2 eV의 indirect band-gap 으로 특성이 변화할 뿐만 아니라 다양한 고유의 전기적 특성을 지니고 있기 때문이다. 그러나 MoS2 는 원자층단위의 layer control 이 어렵다는 이유로 다양한 전자소자 응용에 많은 제약이 보고 되어졌다.

본 연구에서는 MoS2 의 layer 를 control 하기 위해 ICP system 에서 mesh grid 를 삽입하여 Cl2 radical 을 효과적으로 adsorption 시킨 뒤, Ion beam system 에서 Ar+ Ion beam 을 통해 한 층씩 제거하는 방식의 atomic layer etching (ALE) 공정을 진행하였다. ALE 공정시 ion bombardment 에 의한 damage 를 최소화하기 위해 Quadruple Mass Spectrometer (QMS) 를 통한 에너지 분석으로 beam energy 를 20 eV 에서 최적화 할 수 있었고, Raman Spectroscopy, X-ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM) 분석을 통해 ALE 공정에 따른 MoS2 layer control 가능 여부를 증명할 수 있었다.

Keywords: Molybdenum disulfide, atomic layer etching, Ar+ ion beam

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Controllable electromagnetically-induced transparency-like response in a bilayer metamaterial

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Recently, the electromagnetically-induced transparency (EIT)-like effect in metamaterials has attracted enormous interest. Metamaterial analogs of EIT enable promising applications in slow-light devices, low-loss metamaterial, quantum optics, and novel sensors. In this work, we experimentally and numerically studied a bilayer metamaterial for controllable EIT-like spectral response at microwave frequencies. Bilayer metamaterial consists of two snakeshape resonators (SSRs) with one and two bars. The transmission spectra were measured in a frequency range of 4 – 8 GHz in an anechoic chamber at normal incidence. It is found that two SSRs in the metamaterial are activated in bright modes, and the coupling between two bright modes leads to the EIT-like effect, which results in the enhanced transmission at 5.61 GHz. Furthermore, we confirm that the EIT-like feature could be controlled by adjusting the geometric parameters of metamaterial structure. Our work provides a way to tunable EIT-like effect and various potential applications including filters, sensors, and other microwave devices.

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Keywords: Metamaterials, Electromagnetically-induced transparency