Ag-Modified Bi_2Se_3 Nanoplatelets with Enhanced UV–Visible Photodetection

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Abstract

Bi_2Se_3 has emerged as a promising candidate for photodetector applications due to its narrow band gap (~0.35 eV), conductive surface states, and insulating bulk properties. In this study, Bi_2Se_3 nanoplatelets were synthesized on Al_2O_3(100) substrates via thermal evaporation, followed by Ag deposition using the magnetron sputtering technique. The rhombohedral crystal structure of Bi_2Se_3 was confirmed by XRD, HRTEM, Raman spectroscopy, and XPS analyses. The presence and distribution of Ag on the Bi_2Se_3 surface were further verified by FESEM–EDS, XPS, and HRTEM. Optical measurements revealed that the UV–visible absorptance of Bi_2Se_3 nanoplatelets decreased when the Ag content exceeded 7.1 at.%. However, photocurrent responses under zero bias were significantly enhanced by the introduction of Ag. Specifically, the Bi_2Se_3 nanoplatelets containing 7.1 at.% Ag exhibited photocurrents approximately 4.3 and 4.6 times higher than those of pristine Bi_2Se_3 under UV and visible light, respectively. This enhancement is attributed to (i) the intrinsic narrow band gap of Bi_2Se_3, (ii) the formation of a Schottky field at the Ag/Bi_2Se_3 interface, (iii) the LSPR effect of Ag, and (iv) the improved surface conductivity at the heterointerface. These findings demonstrate that optimized Ag deposition can effectively enhance the photosensitivity of Bi_2Se_3 nanoplatelets, highlighting their potential for broadband photodetector applications.

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