PLASMONIC BEHAVIORS OF $MnBi_2Te_4$•n(Bi_2Te_3) IN ULTRAVIOLET (UV) RANGES

ELVIN ALIZADE
Spectroscopic Ellipsometry lab, Institute of Physics, Azerbaijan National Academy of Sciences, AZ 1143 Baku, Azerbaijan
E-mail: AlizadeElv@gmail.com

In the current paper, based on spectral ellipsometry measurements, a strong plasma response in the ultraviolet (UV) spectrum for $MnBi_2Te_4$•n(Bi_2Te_3) compounds was investigated. $MnBi_2Te_4$•n(Bi_2Te_3) is a range of narrow gap ternary semiconductors, also highly interested 3*D* topological insulators. It was found that the plasma response of the studied compounds covers a wide range of the visible region from 1.3*eV* to 6*eV*. For compounds with n=1,2,3,4,5,6 and ∞, the limiting plasma resonance energy for the air/sample surface falls in the UV region of photon energies for the n=0 compound and is not visible in the range measured by the device.

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1. INTRODUCTION

The development of plasmonics and creation of an element based on it for various applications has been updated in recent years. Plasmonics finds applications in metamaterials, metasurfaces, photonic integrated circuits and photonic logic circuits, and other photonic structures. The search for new materials and structures with a plasma response and its control is fundamental at the moment.

The plasma response in structures of the tetradymite type covers a wide region in the visible light spectrum, which is reflected in the results of other authors [1]. The plasma response of semiconductors in the ultraviolet (*UV*) range is probably associated with strong interband transitions or valence electrons. Thus, the study of this phenomenon will provide important information about the nature of band structures and even about topological effects.

2. EXPERIMENT AND RESULTS

The structures under study were characterized using *X*-ray diffractometry and Raman scattering that were previously published in [2].

The measurements of the optical properties for these structures were carried out on a spectroscopic ellipsometer J.A. Woollam *M2000DI* in the range of photon energies from 0.73 to 6.3*eV*. The angles of Ψ and Δ were measured ellipsometrically, and the dielectric function was extracted from the obtained results. Within the framework of this work, only the real part of the dielectric function was studied. The region of the spectrum with a negative real dielectric function is the region with a plasma response.

For excitation of a plasmon, it is important to fulfill the Frohlich condition [3]:

$$|\varepsilon_a + 2\varepsilon_1| = 0$$

Here, ε_a is the dielectric constant of the environment and ε_1 is the real part of the dielectric function.

Figure 1 shows a graph of the real part of the dielectric function in the photon energy range from 1 to 6*eV* with the observed plasma response.

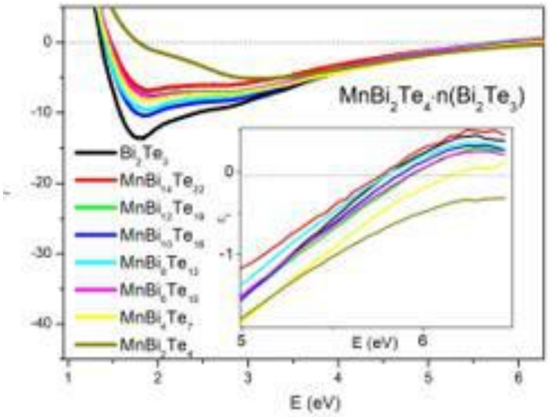

Fig. 1. Graph of the real part of the dielectric function of $MnBi_2Te_4$•n(Bi_2Te_3). Insert: Plot of the real part of the dielectric function at the 0 intersection point.

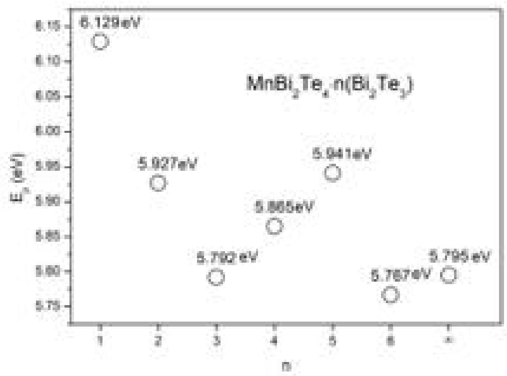

Fig.2. Plasmon resonance energies for $MnBi_2Te_4$•n(Bi_2Te_3) with n=1,2,3,4,5,6

As can be seen from the graphs, the plasma response for different materials covers a wide range of light from 1.3*eV* to 6*eV* and tends to change for different compositions.

131, H.Javid ave, AZ-1143, Baku
ANAS, Institute of Physics
E-mail: jophphysics@gmail.com

Figure 2 shows the energies of the plasmon resonance observed in compositions with different *n*. For *n=0*, plasmon resonance was not observed in the studied spectrum, but this does not mean the absence of plasma resonance.

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