Influence of Surface Preparation on Au/p-Type HgCdTe Interfaces Investigated by XPS Depth Profiling

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P-type metal contacts on semiconductors remain a major technological challenge, particularly in Mercury Cadmium Telluride ($Hg_{1-x}Cd_xTe$) (MCT), a benchmark material for cooled infrared detectors [1]. In line with the SWaP-C (Size, Weight, Power, and Cost) approach, current technological trends aim to increase the operating temperature of infrared devices. Nevertheless, increasing temperature is accompanied by anomalous pixel responses and enhanced noise levels. One possible origin of this degradation is attributed to non-ideal, Schottky-type behavior at the metal/p-type MCT interface.

Among the different strategies proposed to improve contact quality, surface preparation prior to metallization plays a critical role through the reduction of interface defects, passivation of dangling bonds, reduction of interfacial oxides, and possible Fermi-level pinning effects. Interactions between metals and MCT were extensively investigated by X-ray photoelectron spectroscopy (XPS) in the 1990s [3]. However, the mechanisms governing contact formation remain insufficiently understood. To further elucidate the processes controlling this interface and assess the importance of surface preparation, we performed a detailed physicochemical characterization using X-ray Photoelectron Spectroscopy (XPS) combined with gentle Ar^+ sputter depth profiling. The objective was to gain deeper insight into both metal contact formation on MCT and the interfacial reactivity as a function of surface preparation.

Gold thin-film contacts (~10 nm) were deposited on arsenic-doped p-type $Hg_{1-x}Cd_xTe$ ($x = 0.29$) with a carrier concentration of approximately 10^{18} cm^{-3}. Two different surface preparation routes prior to metallization were investigated : (i) a deoxidized surface obtained by dry plasma treatment followed by wet chemical etching, and (ii) a deliberately oxidized surface prepared by plasma treatment only. Depth profiles of the contact/interface region were analyzed by XPS using an Al Kα X-ray source (Quantes, ULVAC-PHI) combined with low-energy Ar^+ sputtering. Quantification data were corrected using sputter sensitivity factors determined from a non-metallized reference MCT sample.

The measurements revealed strong preferential sputtering effects following the sequence Hg >> Te > Cd, attributed to the fragility of Hg–Te bonds [4]. After correction, the sputter depth profiles revealed that the Au/MCT interface formed on the intentionally oxidized surface was significantly sharper than that obtained on the deoxidized surface. Surface deoxidation prior to metallization appears to promote Au diffusion into the MCT as well as reciprocal interdiffusion processes. In contrast, the plasma-grown oxide layer, unlike the thin native oxide formed after air exposure following treatment, contains a higher contribution of HgO and CdTeO species, which likely stabilizes the surface and acts as a potential barrier against Au interdiffusion during deposition. Such diffusion phenomena may strongly influence the electrical quality of the contacts through the generation of interfacial defects, modification of the local stoichiometry, and Au-induced doping effects.

Keywords:

HgCdTe – X-ray Photoelectron Spectroscopy (XPS) – Depth Profiling – Metal/Semiconductor Interface – Schottky Contact

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