Investigation of electro-physical properties of $Cr/p\text{-}Hg_{0.72}Cd_{0.28}Te$ and $Cr/p\text{-}CdTe/Hg_{0.72}Cd_{0.28}Te$ contacts

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The design of MCT IR detectors involves a number of challenges, one of which is the decomposition of the MCT material in the surface layer, making it undesirable to perform technological processes or store the devices at relatively high temperatures (T > 100 °C). It should be taken into account also the fragility of the material, the possible mutual diffusion of metals deposited on the HgCdTe surface when making contacts, etc. [1].

CdTe films on the surface of $Hg_{0.72}Cd_{0.28}Te$ monocrystalline epitaxial layers, grown by Liquid Phase Epitaxy (LPE) method on the CdZnTe (111) substrates, were formed using the Hot Wall Epitaxial (HWE) method, which is one of the variations of the thermal gaseous vacuum sputtering. CdTe films ($d \approx 400$ nm) grown under the low-temperature conditions ($T \leq 100$ °C) by the HWE technique, have been chosen as protective coatings to the MCT surface.

Two types of contacts, which can be used for designing of IR detectors for 3 to 5 µm spectral range: $Cr/p\text{–}CdTe/p\text{–}Hg_{0.72}Cd_{0.28}Te$ and $Cr/p\text{–}Hg_{0.72}Cd_{0.28}Te$, were formed by the magnetron sputtering. For the "Linear Transmission Line Model" (LTLM) method, a structure topology with selected areas for contact metallization was chosen for subsequent measurements of electrophysical characteristics (Fig. 1).

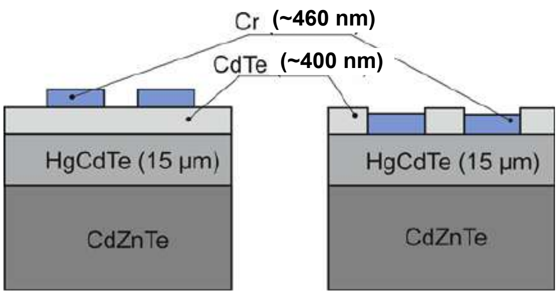
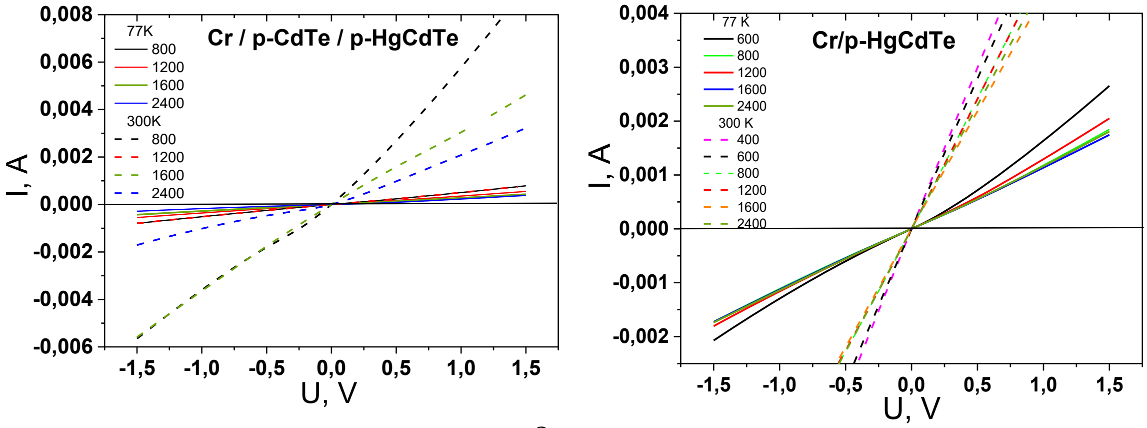


Fig.1. The schematic cross-section of fabricated structures $Cr/p\text{-}CdTe/p\text{-}Hg_{0.28}Cd_{0.72}Te/CdZnTe$ and $Cr/p\text{-}Hg_{0.28}Cd_{0.72}Te/CdZnTe$.

Several sets of test structures with the dimensions of the contact pads of L=40 µm (length) and W=2060 µm (width) were used. The scheme of structure for LTLM method with the following values of the gap between Cr contacts in microns: L_1=400 μm, L_2=600 μm, L_3=800 μm, L_4=1200 μm, L_5=1600 μm, L_6=2400 μm. Measured I–V characteristics in both samples are presented in fig.2.



a

b

Fig.2. Current-voltage characteristics of contacts for Cr/p-CdTe/p-$Hg_{0.28}Cd_{0.72}Te$ (a) and Cr/p-$Hg_{0.28}Cd_{0.72}Te$ (b) samples, respectively, at temperatures of 77K and 300K. The insets show distances in microns between adjacent pairs of contact lines.

This work shows that it was possible to form interfaces Cr/p-CdTe/p-$Hg_{0.28}Cd_{0.72}Te$ та Cr/p-$Hg_{0.28}Cd_{0.72}Te$ with Ohmic properties, which remain stable at temperatures T≈80 and 300 K. Values of specific contact resistance ρ_c for Cr/p-CdTe/p-$Hg_{0.28}Cd_{0.72}Te$ are $\rho_{c(300K)}$=(0.03÷0.28) Ω·cm^2 and $\rho_{c(77K)}$=(0.30÷0.34) Ω·cm^2 and for Cr/p-$Hg_{0.28}Cd_{0.72}Te$ are $\rho_{c(300K)}$=(0,02÷0,11) Ω·cm^2 and $\rho_{c(77K)}$=(0,15÷0,22) Ω·cm^2, respectively. The mechanism of current transport through the Cr/p–CdTe/p–$Hg_{0.72}Cd_{0.28}Te$ and Cr/p–$Hg_{0.72}Cd_{0.28}Te$ interfaces was explained with using the MIGS (metal-induced gap states) model in the semiconductor. Accounting of the relatively large series resistance of bulk semiconductor films and large area resistance of Schottky barriers, explain the linear or almost linear I–V characteristics in the LTLM configuration for these structures.

1. Rogalski, A. Next decade in infrared detectors, Proc. SPIE., 10433, 104330L–22 (2017).