Electrical properties of photosensitive *n*-$MnFe_2O_4$/*n*-CdTe heterojunctions

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Introduction

Thin films of manganese ferrite $MnFe_2O_4$ grown by spray pyrolysis have a band gap $E_g \approx 2.1$ eV [1]. This value is in the range between the values for transparent conducting oxides (TCO) ($E_g > 3$ eV) and for effectively light-absorbing semiconductors (1.1 eV $< E_g <$ 1.6 eV), such as CdTe ($E_g \approx 1.5$ eV). Materials with energy parameters similar to $MnFe_2O_4$ are successfully used as a buffer layer in CdTe-based heterostructures. In this case, the material of the buffer layer forms a high-quality heterojunction with the base semiconductor.

Experimental technique

The *n*-CdTe substrates with electrical conductivity $\sigma = 1.4$ $\Omega^{-1}\cdot cm^{-1}$ were used to manufacture *n*-$MnFe_2O_4$/*n*-CdTe heterojunctions. The *n*-$MnFe_2O_4$ films with a thickness of $w \approx 0.5$ μm were deposited onto the *n*-CdTe surface by spray pyrolysis from 0.1 M aqueous solutions of $MnCl_2\cdot 6H_2O$ and $FeCl_3\cdot 6H_2O$ salts.

Experimental results and their discussion

The current rectification factor of the *n*-$MnFe_2O_4$/*n*-CdTe heterojunction at $T = 295$ K is 10^4 at the voltage $|V| = 2$ V (Fig.1). The main component of the series resistance ($R_S \approx 900$ Ω) in the structure is a high-resistance *n*-$MnFe_2O_4$ film ($\rho \approx 10^6$ Ω·cm). In the region of forward biases $3kT/q < V < 0.36$ V of the *n*-$MnFe_2O_4$/*n*-CdTe heterojunction, the tunneling-recombination current flow mechanism is realized, which, at voltages $V > 0.36$ V, passes into recombination in the space charge region (SCR) with a diode coefficient A ≈ 2. At reverse biases in the voltage range -2.5 V $< V <$ $-3kT/q$, the main mechanism of current generation is the generation of charge carriers in the SCR. The *C*-*V*-characteristics of the *n*-$MnFe_2O_4$/*n*-CdTe heterojunction are characterized by their frequency shift along the capacitance axis due to the presence of series resistance in the structure. The contact potential difference at the heterojunction determined using the dependences $C^{-2} = f(V)$ is $\varphi_k = 0.92$ V (Fig.2). The *n*-$MnFe_2O_4$/*n*-CdTe heterojunction generates ~0.56 V at 12000 lux illumination. The photocurrent density is 100 μA/cm^2. The fabricated heterojunctions are suitable for use as photodetectors of visible radiation.

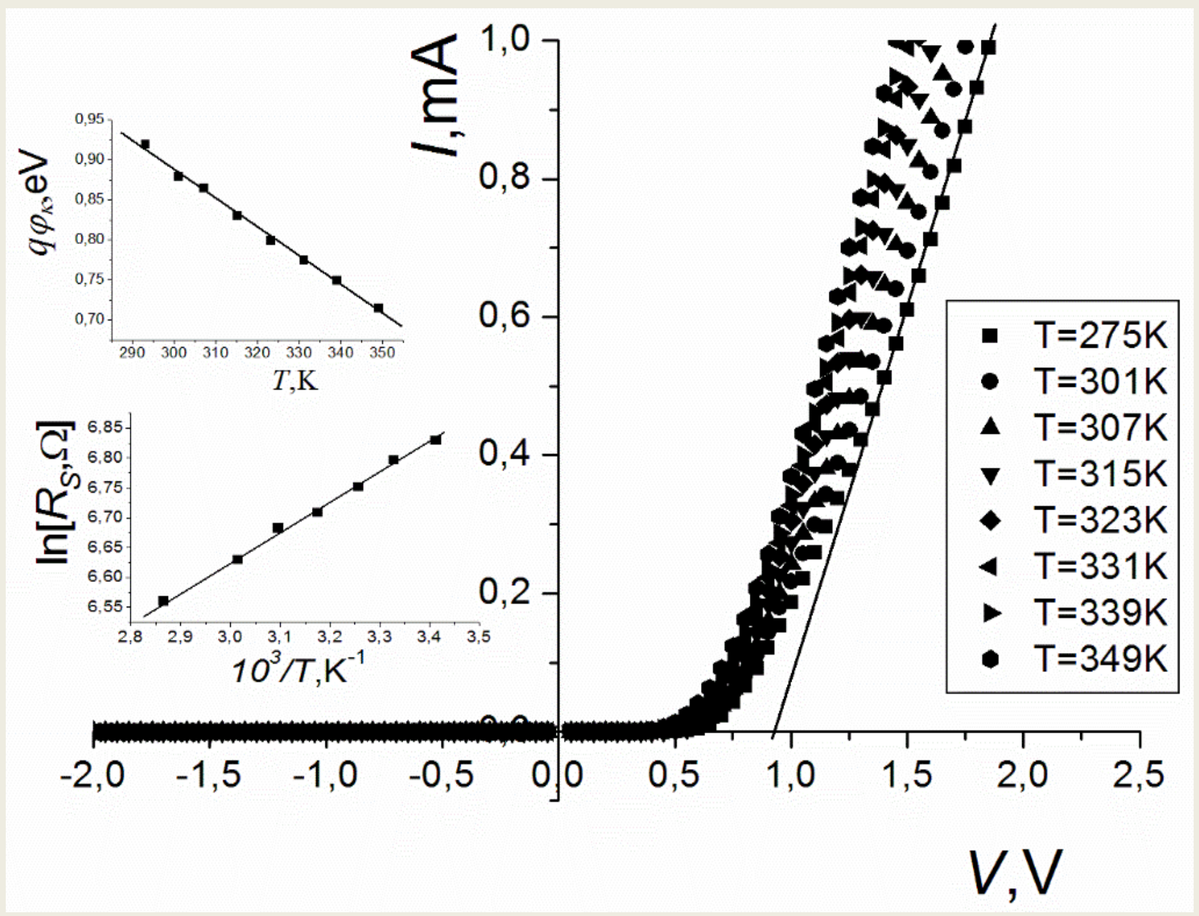

Fig. 1. *I*-*V*-characteristics of the *n*-$MnFe_2O_4$/*n*-CdTe heterostructure in the temperature range from 275 K to 349 K (insets - temperature dependence of $q\varphi_k$ and R_S)

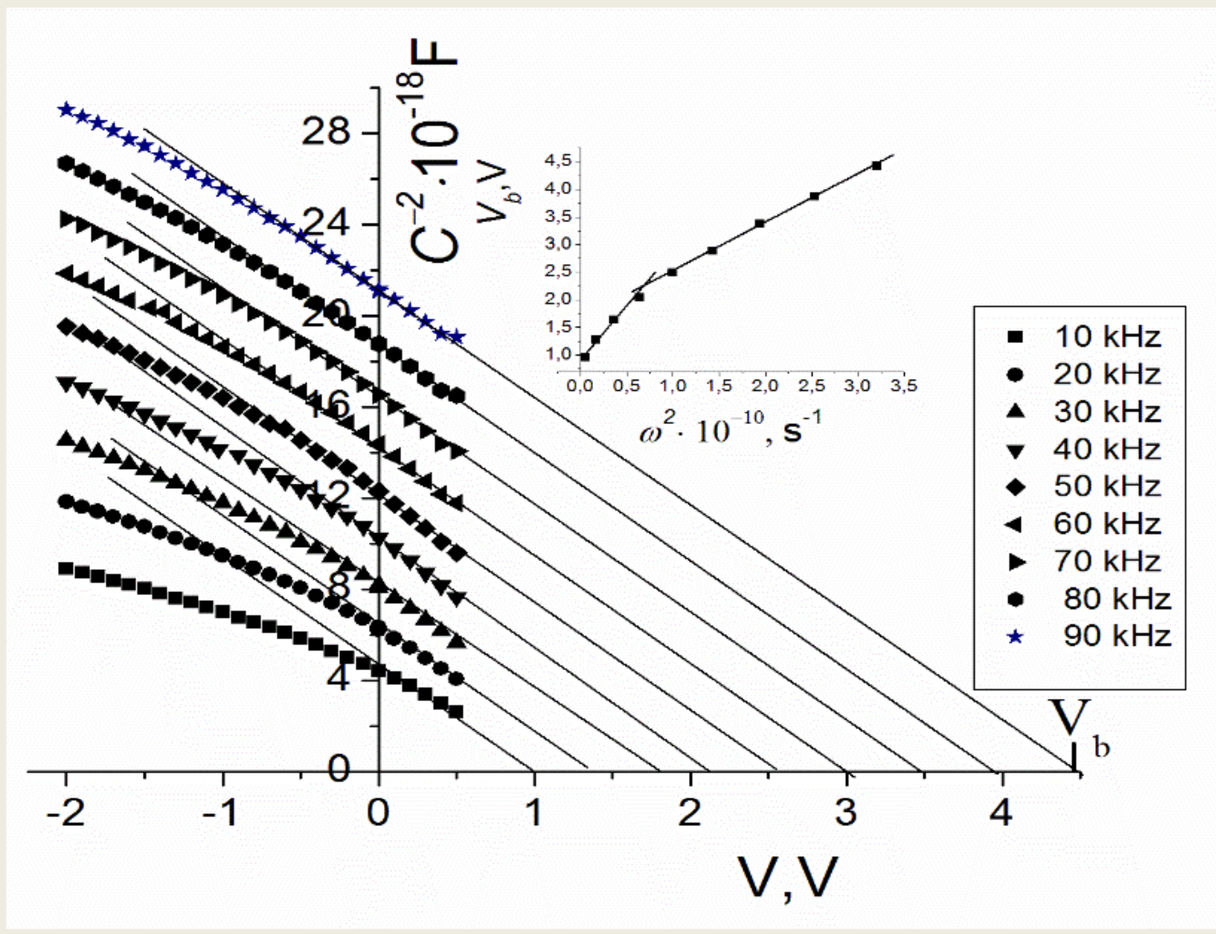

Fig. 2. Dependences $C^{-2} = f(V)$ of the *n*-$MnFe_2O_4$/*n*-CdTe heterostructure at different frequencies (inset – the dependence of the extrapolation voltage V_b on ω^2 to determine φ_k)

References

1. *Nagarajan V., Thayumanavan A.* Spray deposited $MnFe_2O_4$ thin films for detection of ethanol and acetone vapors // Appl Surf Sci.-2018.-**428**. - P. 748–756.