SCHOTTKY BARRIER HEIGHT AND IDEALITY FACTOR OF CVD GRAPHENE/n-Si HETEROJUNCTION

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I. INTRODUCTION

Due to high optical transparency and high charge mobility graphene emerges as a perspective material for transparent electrode in photodetectors. It made a new turn in using novel 2D materials in combination with the standard silicon technology. From the electronic point of view, when an intimate contact between graphene and silicon is established the Schottky barrier is formed. According to the standard Schottky model the current through the heterojunction semiconductor/metal can be written as

$$lnI = ln\, I_0 - \frac{e}{\eta kT} V \qquad (1)$$

where $I_0 = AA^{*}T^2 e^{-\frac{\Phi_B}{kT}}$, k – Boltzmann constant, Φ_B – barrier height, T – temperature, A – square of active area, A^{*} – Richardson constant (≈112 $Acм^{-2}K^{-2}$), η–ideality factor. The barrier height together with the ideality factor are not universal parameters and depends on many aspects, including graphene doping level, transfer technology, the state of Si surface and so on. Moreover, these parameters are crucial for the performance of photodetectors based on graphene/Si heterojunctions.

II. RESULTS

In this work we demonstrate the experimental IV characteristic of graphene/n-Si heterojunction and evaluate its barrier height and ideality factor.

For the device fabrication, graphene growth was performed through the atmospheric pressure chemical vapour deposition using methane as a precursor. After the growth graphene was transferred onto structured n-Si substrates with metallic contacts by a wet-chemical process without using polymeric frame. The sketch of the structure and the measurement scheme are shown in Fig.1. The IV characteristic of fabricated device measured in dark conditions is presented in Fig. 2. The experimental data follows the typical Schottky junction dependency. For the barrier height and quality factor evaluation the experimental dependency was replotted in *ln* scale, see Fig 3. Following the standard Schottky model I_0 and consequently, barrier height is extracted from the intersection of the linear fit (red line in figure 3) with *I* axis, whereas the ideality factor can be obtained from the slope of the linear fit. The fitting procedure leads to the following parameters: ideality factor η ≈ 5, barrier height Φ_B = 0,422 eV.

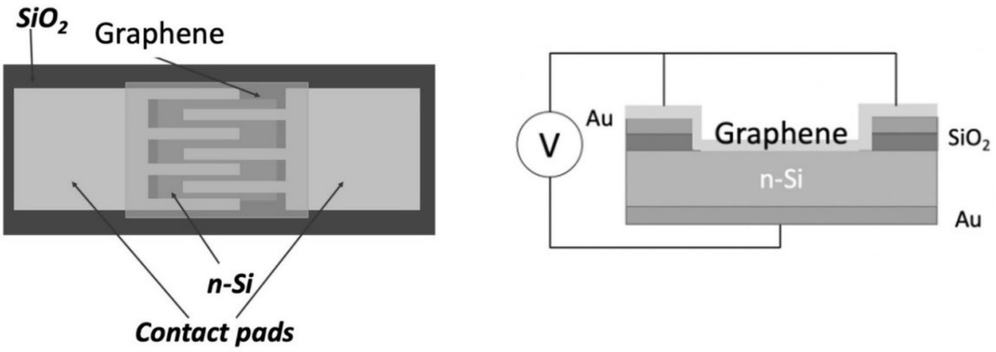

Figure 1. Top view of the structure (left) and measurement scheme (right) of the studied sample

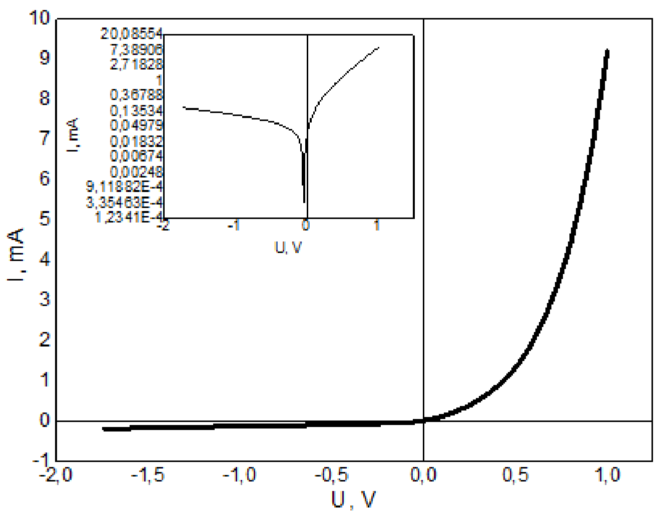

Figure 2. The experimental IV characteristic of the CVD graphene/n-Si heterostructure measured in dark conditions. The inset show the experimental data plotted in semi-log scale

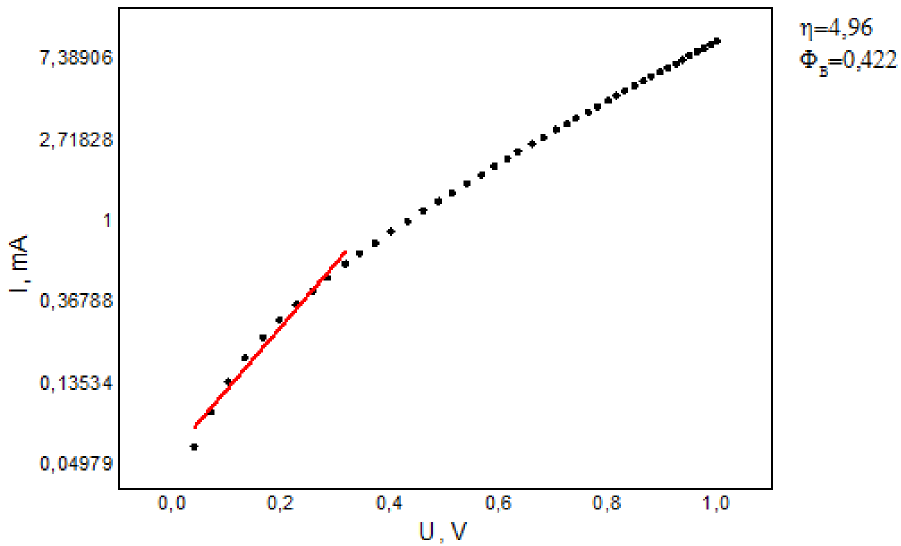

Figure 3. The positive part of experimental IV dependency plotted in ln scale, the red line represents the fitting to Schottky model (see the main text for more details)

The value of Si affinity (4.05 eV) together with the Schottky barrier height gives graphene work function $\phi_{gr} \sim 4.5$ eV, what is in very good agreement with the values reported for graphene [1]. The ideality factor also agrees with the values which can be found in the literature [2].

III. CONCLUSIONS

We fabricated and measured IV characteristic of CVD graphene/n-Si heterojunction. Based on the standard Schottky model ideality factor $\eta \approx 5$ and barrier height $\Phi_B = 0{,}422$ eV were extracted from the experimental data. Our results show the perspective of studied heterojunction for photodetection application.

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