Doping effect and phase transition of $MoTe_2$ by laser irradiation and TFET application

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Transition metal dichalcogenides (TMDCs) have been attracted a lot of interest due to their interesting electrical and optical properties [1]. $MoTe_2$, one of TMDC materials, has a relatively small band gap (0.9 eV) compared to MoS_2 hence it is easy to show ambipolar gate action. In $MoTe_2$ crystal, Te atoms can easily be knocked off from the crystal by laser irradiation, and then the vacancies can act as impurity sites [2,3]. In our recent study, we have succeeded control the carrier density control even including the n/p inversion by laser irradiation. In addition, $MoTe_2$ has a low potential barrier for a polymorphic structural change from 2H to 1T'even by stretching the crystal [4]. Laser irradiation has been considered as one of the promising key tools to control the polymorphism [5], however our recent study suggests that the material derived by strong-laser irradiation is not such a structural phase transition but a decomposition of a $MoTe_2$ crystal. Nevertheless, we have succeeded to realize a very good ohmic contact by laser-induced semi-metallic Te region for both n-and p-type $MoTe_2$. According to our component analysis using EDX, the ratio of Mo and Te was reduced to be 1:1 in the residue at the irradiated region. And then, heavily doped regions were formed besides the decomposed region. Furthermore, we found that the carrier polarity can be controlled by selecting the environment during the irradiation. Using such techniques, we have demonstrated to realize a CMOS inverter and a tunneling field effect transistor (TFET) using exfoliated multilayer $MoTe_2$ crystals.

Reference

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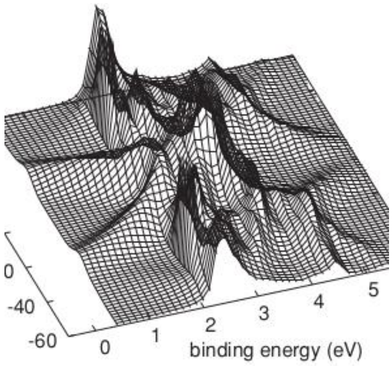

Figure 1. Theoretical ARPES of Cu(111) for He I light and emission angle of 60 deg [2].

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