Anomalous photoconductivity in topological crystalline insulator $Pb_{1-x}Sn_xTe$

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PbTe compounds have been used for the development of infrared photodetectors [1] over the decades. The introduction of Sn atoms makes this material even more interesting for practical applications as well as from the basics physics point of view. According to the band inversion model, the energy gap of $Pb_{1-x}Sn_xTe$ decreases as the Sn composition increases, and vanishes for an intermediate alloy composition. Further increasing of Sn content leads to the band inversion and the energy gap starts to increase up to the SnTe value. The temperature at which band inversion occurs depends on the Sn content. Very recently, it was discovered that in the region of band inversion, a transition from a metallic to a crystalline topological insulator (TCI) occurs [2], revealing a new condensed matter state. In this work, we present the results of photoconductivity measurements performed in $Pb_{1-x}Sn_xTe$ film for x~0.40. The positive photoconductivity, commonly observed for PbTe samples, changes to a negative photoconductivity at room temperature and its amplitude increases as temperature decreases. At temperature where band inversion occurs, the signal of the photoconductivity changes sign. This effect can be related to the topological states. In order to explain the anomalous behavior of the photoconductivity, we perform Hall measurements and morphological characterization. From the decay photoconductivity curves, one can obtain the recombination times as a function of temperature and hence the energy depth of the traps. After the analysis, we will obtain a detailed description of the photoconductivity effect in the topological insulator region. We also expect that these new information shed some light about the carrier transport via topological surface states.

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References:

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