Three-Dimensional Dirac Semimetal–Insulator Transition in $(Cd_{1-x}Zn_x)_3As_2$ Bulk Crystals

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Presently it is well established, both theoretically [1] and experimentally [2], that Cd_3As_2 is a three dimensional Dirac semimetal where the valence and conduction bands touch at two points in reciprocal space with a linear dispersion. However, this material is strongly *n*-type with electron concentration usually exceeding 10^{18} cm^{-3} . Since this indicates that the Fermi energy is risen hundreds of meV above the Dirac points, they are not directly accessible by the electron transport measurements. On the other hand, Cd_3As_2 and Zn_3As_2 form a solid solution $(Cd_{1-x}Zn_x)_3As_2$ in the whole range of *x*. Because Zn_3As_2 is a trivial p-type semiconductor with E_g = 1 eV [3], a transition between the Dirac semimetal and insulator phase is expected around *x*=0.38[4]. Simultaneously, one expects transition from *n*-type to *p*-type conductivity, which should lower the Fermi energy and enable direct access to the Dirac cones.

In the present work we report on new electron transport measurements performed on bulk crystals of $(Cd_{1-x}Zn_x)_3As_2$, where *x* changes from 0 to 0.92. They are obtained by the growth from molten phase. The crystal sizes are of the order of several millimeters. For $x < 0.35$ the samples are strongly *n*-type with the Hall electron concentration of the order of 10^{18} cm^{-3}. Their mobilities are above 10^4 cm^2/Vs for all values of *x* in this range, and they show pronounced Shubnikov-de Haas oscillations for $T < 50$ K. However, for higher Zn content, $x = 0.42$, the conductance becomes p-type and it drops by 6 orders of magnitude in comparison with that of *x*=0.35. Additionally, it strongly decreases with lowering the temperature, indicating insulating behavior. For yet higher Zn content, $x = 0.92$, we observe restoring of the metallic behavior, but the conductance is p-type in the whole temperature range from 1.8 K to 300 K. In summary, we have observed Dirac semimetal-insulator transition in $(Cd_{1-x}Zn_x)_3As_2$ as a function of *x*, which opens new possibilities in studies of the topological phases.

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