Doping induced metallization of a narrow gap insulator FeGa$_3$

MONIKA GAMZA, Brookhaven National Laboratory, AKSHAT PURI, Stony Brook University, JAN TOMCZAK, Rutgers University, JIM QUINN, Stony Brook University, MEIGAN ARONSON, Stony Brook University and Brookhaven National Laboratory — Narrow gap semiconductors attract great interest owing to an unusual metallization process which remains poorly understood despite decades of extensive research [1]. Here, we report on the effects of hole doping on properties of a nonmagnetic semiconductor FeGa$_3$ with a band gap of 0.4 eV [2]. By means of electrical resistivity, magnetization and specific heat measurements performed on single crystals grown from gallium flux we have found that a substitution of Mn for Fe in Fe$_{1-x}$Mn$_x$Ga$_3$ (0.005 < $x$ < 0.03) yields an insulating state at high temperatures with residual magnetic moments. With lowering temperature, resistivity deviates from an activation-type behavior and nearly saturates at T < 100 K. Finally, it drops by as much as two orders of magnitude at temperature of 6 K, indicating a metal-insulator transition. Magnetization measurements did not show magnetic order associated with the transition. When an external magnetic field is applied, the metal-insulator transition moves to lower temperatures and eventually the resistivity returns to the insulating-type behavior in fields higher then of 5 Tesla.