Insulator-to-Metal Phase Transition in a Few-Layered $MoSe_2$ Field Effect Transistor

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I. SUPPLEMENTARY INFORMATION

Figure S1: The conductivity data vs temperature in semi-logarithmic scale is plotted in Figure 1. This is the same data shown in the main body in Fig. 3(a). This semi-logarithmic plot clearly shows the insulating behavior of the $MoSe_2$ at low applied gate voltage, V_{bg}, where the conductivity decreases with decreasing temperature. When the gate voltage increased the slope of the conductivity changed, and above a certain threshold of applied voltage (marking a critical density of charge carriers induced by the applied gate voltage) the slope of the conductivity data changed sign compared to the insulating phase conductivity.

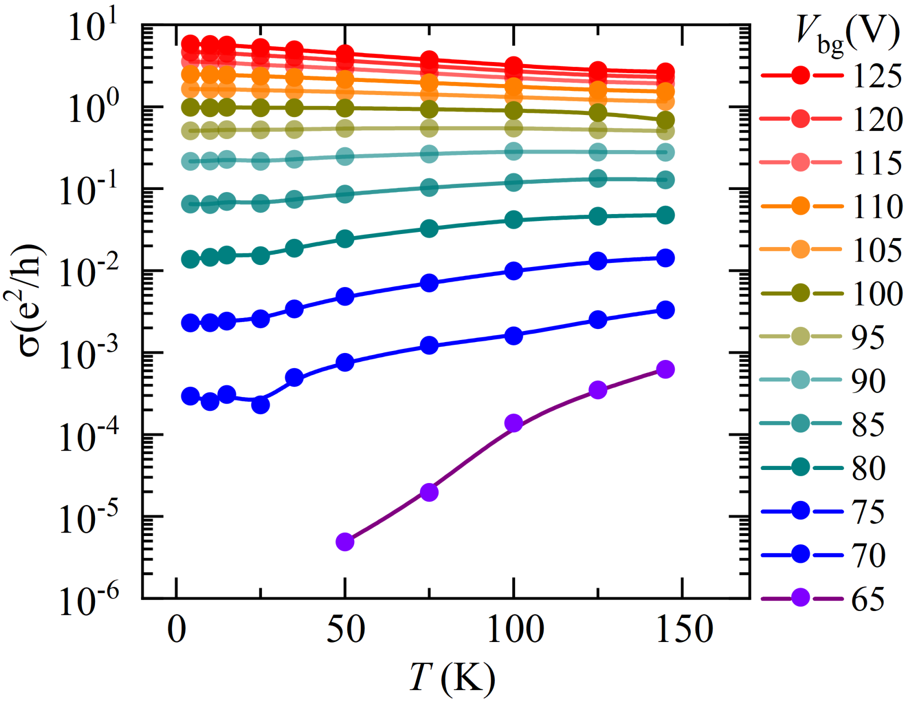

FIG. S1: Conductivity measured using 4-terminal method plotted as function of temperature in semi-logarithmic scale. The sample became too resistive to measure below 50 K for $V_{bg} = 65$ V

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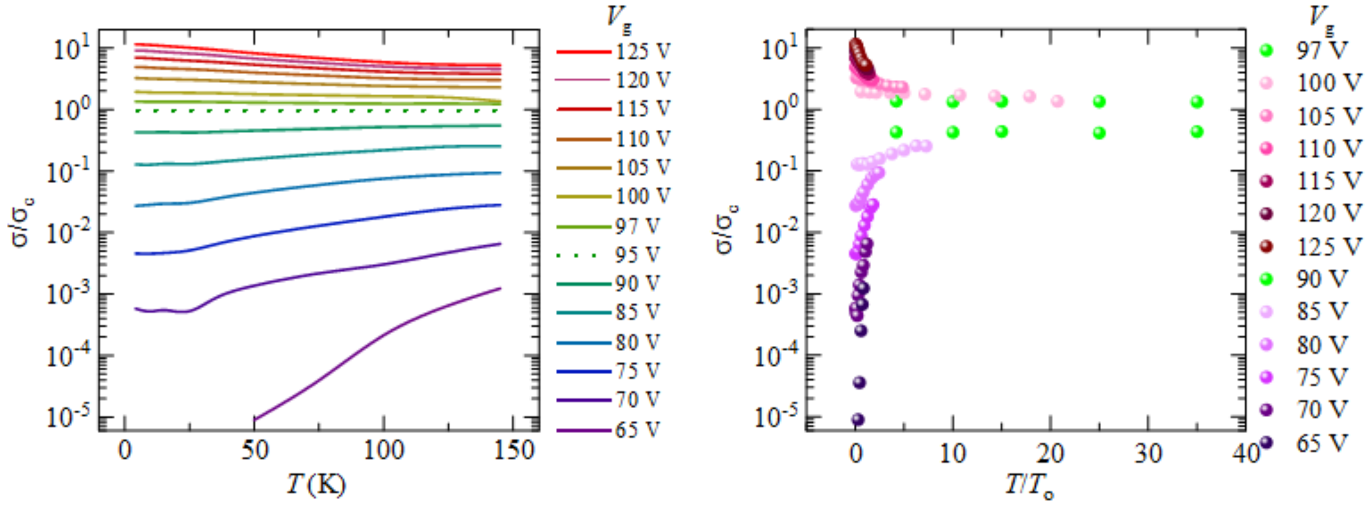

FIG. S2: (left) Conductivity, σ, curves normalized by the critical conductivity σ_c(T, V_{bg} =95 V, depicted by the dashed line) at the critical carrier density $n_c = n(V_{bg} = 95$ V) as functions of the temperature T. (right) Plotting the rescaled conductivity, σ/σ_c as a function of the rescaled temperature, T/T_0, showed no collapse of the conductivity curves to a single line that would indicate a quantum-critical aspect of the phase transition.

Figure S2: We plotted the temperature-dependent conductivity, σ, by normalizing all the curves with the critical conductivity value, σ_c, shown in Fig. 2 (left). Critical conductivity σ_c is represented by a dashed line which separates the insulating branch of the conductivity (below σ_c) and the metallic branch of the conductivity (above σ_c). In a quantum phase transition (QPT), the material undergoes a phase transition at T=0 K. The QPT occurs at the quantum critical point, which is where quantum fluctuations drive the transition to diverge and become scale-invariant in space and time. Experimentally, the two branches of the conductivity should scale with a temperature parameter, T_o, in such a way that

$$T_o \propto \delta n^{z\nu} \tag{1}$$

where $\delta n = (\frac{n-n_c}{n_c})$. z and ν are the dynamic and correlation exponents, respectively. This suggests that the two branches of the conductivity should collapse into a single curve with appropriate T_o values. As demonstrated from the fitting of Fig. 2 (right), we have not established any collapse of the conductivity curves on either branch, which indicated that our phase transition did not exhibit quantum criticality.