Metal to insulator quantum-phase transition in few-layered ReS$\textsubscript{2}$

NIHAR PRADHAN, DANIEL RHODES, ZHENGUANG LU, DMITRY SMIRNOV, EFSTRATIOS MANOUSAKIS, VLADIMIR DOBROSAVLJEVIC, LUIS BALICAS, NHMFL, Tallahassee, FL-32310, USA, AMBER MCCREARY, SIMIN FENG, MAURICO TERRONES, Dept. of Physics, Penn State University, PA 16802, USA, RAJU NAMBURU, MADAN DUBEY, U.S. Army Research Laboratory, Adelphi, MD 20783, USA, ANGELA HIGHT WALKER, NIST, Gaithersburg, MD-20899, USA, HUMBERTO TERRONES, Dept. of Physics, RPI, NY 12180, USA — ReS$\textsubscript{2}$ behaves as an $n$-type semiconductor with an intrinsic carrier mobility surpassing $\mu_i \sim 30 \text{ cm}^2/\text{Vs}$ at $T = 300 \text{ K}$ which increases up to $\sim 350 \text{ cm}^2/\text{Vs}$ at 2 K. Semiconducting behavior is observed at low electron densities $n$, but at high values of $n$ the resistivity decreases by a factor $>7$ upon cooling to 2 K and displays a metallic $T^2$-dependence. The electric-field induced metallic state observed in MoS$\textsubscript{2}$ was recently claimed to result from a percolation type of transition. Instead, through a scaling analysis of the conductivity as a function of $T$ and $n$, we find that the metallic state of ReS$\textsubscript{2}$ results from a second-order metal to insulator transition driven by electronic correlations.

$^1$Supported by U.S. Army Research Office MURI Grant No. W911NF-11-1-0362