# Superconductivity induced by Fe doping in 1T-$TaS_2$ single crystals

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Charge-density wave (CDW) and superconductivity (SC) are collective states that coexist in layered transition-metal dichalcogenides (TMD). The nature of the relationship (competition or/and cooperation) between CDW and SC remains to be further elucidated. Here we report the SC that develops within the CDW state, and the electronic phase diagram in the Fe-doped 1T-$TaS_2$ single crystals. The single crystals of $Fe_xTa_{1-x}S_2$ ($x = 0 \sim 0.05$) were successfully grown via the chemical vapor transport (CVT) method with iodine as a transport agent. Our experimental and density-functional theory (DFT) calculation results show a semimetal behavior in undoped 1T-$TaS_2$ due to the pseudo-gap occurring in CDW phase. With Fe doping, the commensurate CDW state is suppressed and the induced new SC state appears at low temperatures for samples with moderate doping levels ($x = 0.02$ and 0.03). The magnetic property measurements evidently indicate a type-II superconductor with low superconducting critical fields. We propose that the induced SC and CDW phases are separated in real space. For high Fe-doping concentration ($x \geq 0.04$), the Anderson localization (AL) state is observed due to the disordered/random potential, which results in an insulating behavior. We think this is the first report of the induced SC by doping and the complete electronic phase diagram in Fe-doped 1T-$TaS_2$ system.