Electrostatic carrier doping (ESD) using the field-effect transistor (FET) principle is recently expanding the range of target materials. Strongly-correlated materials are good candidates for phase transition transistors, because an insulator-to-metal transition (e.g. Mott transition) is expected. Recently, we have demonstrated an electric field-induced Mott transition in a thin-single crystal of κ-BEDT-TTF salt [1, 2]. This is the first observation of a band-filling-controlled Mott transition in an FET. We present here the ESD into κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Cl (κ-Cl) near the band-width-controlled Mott transition. We fabricated a single crystal FET of κ-Cl with a plastic (polyethylene naphtalate) substrate. The combination of ESD and strain effects induced by bending the substrate enables coregulation of "bandwidth" and "band-filling" in κ-Cl.

The κ-Cl on the substrate exhibited a superconducting behavior due to the positive pressure from the substrate. The κ-Cl showed a superconductor-to-insulator transition by applying the strain-effects (effective negative pressure). Successively, we tried ESD into the κ-Cl under the strain. Interestingly, we found the field-effects also in the mixed state occurred during the Mott transition (Fig. 1). Remarkable device mobility, ca. 280 cm$^2$/Vs was obtained in this region although the ON/OFF ratio was only 10%. These abnormal field-effect and device mobility indicates that the superconducting fraction emerged by ESD into the insulating phase in the mixed state.