High performance unipolar MoTe$_2$ field effect transistors enabled by doping and Al$_2$O$_3$ capping $^1$ DESHUN QU, XIAOCHI LIU, FAISAL AHMED, WON JONG YOO, Sungkyunkwan Univ — We carry out the first systematic experiment on carrier type modulation of MoTe$_2$ FET in this work. Unipolar p- and n-type MoTe$_2$ FETs with $10^5$ and $10^6$ on-off ratios are achieved through rapid thermal annealing (RTA) and Benzyl Viologen (BV) doping respectively. By varying the vacuum level in RTA chamber before annealing and BV dopant concentration, annealing condition, both hole and electron doping concentration can be modulated in a wide range from slight doping to degenerate like doping. Furthermore, Al$_2$O$_3$ is deposited onto the device surfaces for the mobility engineering. Hole and electron mobilities are improved to 62 cm$^2$/Vs and 82 cm$^2$/Vs respectively after Al$_2$O$_3$ capping; they are among the highest carrier mobilities of MoTe$_2$ transistors ever obtained. A lateral homogeneous MoTe$_2$ p-n diode is fabricated combining the electron and hole doping techniques, the device displays excellent diode properties with a high rectification ratio of $10^4$ at 0 gate bias and an ideality factor of 1.2.

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