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MoS_2 Transistors Operating at Gigahertz Frequencies

DARIA KRASNOZHON, DOMINIK LEMBKE, CLEMENS NYFFELER, YUSUF LEBLEBICI, ANDRAS KIS, Electrical Engineering Institute, Ecole Polytechnique Federale de Lausanne (EPFL) — The presence of a direct band gap and an ultrathin form factor has caused a considerable interest in 2D semiconductors from TMD family with MoS_2 being the most studied representative of this family of materials. While diverse electronic elements, integrated circuits and optoelectronic devices have been demonstrated using ultrathin MoS_2 and related materials, very little is known about their performance at high frequencies. We fabricated top-gated MoS_2 transistors operating in the gigahertz range of frequencies. The presence of a band gap also gives rise to current saturation, allowing voltage gain higher than 1. The RF transistors are fabricated from exfoliated MoS_2 with different layer thickness. All our devices presented transconductance typical of n-type materials with on-state current reaching 300 μA/μm for $V_{\mathrm{ds}} = 2$ V and gate voltage $V_{\mathrm{tg}} = 10$ V in the case of monolayer MoS_2. The current gain of the MoS_2 FETs decreases with increasing frequency and shows the typical $1/f$dependence. In conclusion, we studied top-gated MoS_2 transistors with a 240 nm gate length. Our MoS_2 RF-FETs show an intrinsic transconductance higher than 50 uS/um and a drain-source current saturation with a voltage gain higher than 1. Our devices show cut-off frequencies in the GHz range and are able not only to amplify current in this frequency range but also power and voltage, with the maximum operating frequency $f_{\mathrm{max}} = 8.2$ GHz.

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