Negative Differential Transconductance in a MoS\textsubscript{2}/WSe\textsubscript{2} Heterojunction Field Effect Transistor

AHMAD ZUBAIR, Massachusetts Institute of Technology, AMIRHASAN NOURBAKHSH, Massachusetts Institute of Technology, IMEC, MILDRED DRESSELHAUS, Massachusetts Institute of Technology, STEFAN DE GENDT, IMEC, TOMAS PALACIOS, Massachusetts Institute of Technology — In this work, we demonstrate the negative transconductance in heterojunction transistors made of two-dimensional materials for the first time. Negative transconductance plays a key role in multi-valued logic/memory and frequency multiplication circuits. The simpler fabrication method of stacked van der Waals heterostructures compared to the conventional bulk semiconductors and large area CVD growth of the layered 2D materials systems makes it a prime candidate for scalable novel applications of their heterostructures. Vertically stacked MoS\textsubscript{2}/WSe\textsubscript{2} heterostructures are fabricated by mechanical exfoliation and an in-house dry transfer process. A two-step process of e-beam lithography and metal deposition (Au on MoS\textsubscript{2}, and Pd on WSe\textsubscript{2}) were performed to fabricate n-type MoS\textsubscript{2} and ambipolar WSe\textsubscript{2} FET. The transfer characteristics on the non-overlapping regions shows the expected characteristics of the n-type, MoS\textsubscript{2} FET and ambipolar WSe\textsubscript{2} FET. At the same time, the transfer characteristics of the overlapping region between MoS\textsubscript{2} and WSe\textsubscript{2} show negative differential transconductance. With proper scaling and careful optimization this negative differential transconductance will lead to novel applications.

Ahmad Zubair
Massachusetts Institute of Technology

Date submitted: 14 Nov 2014