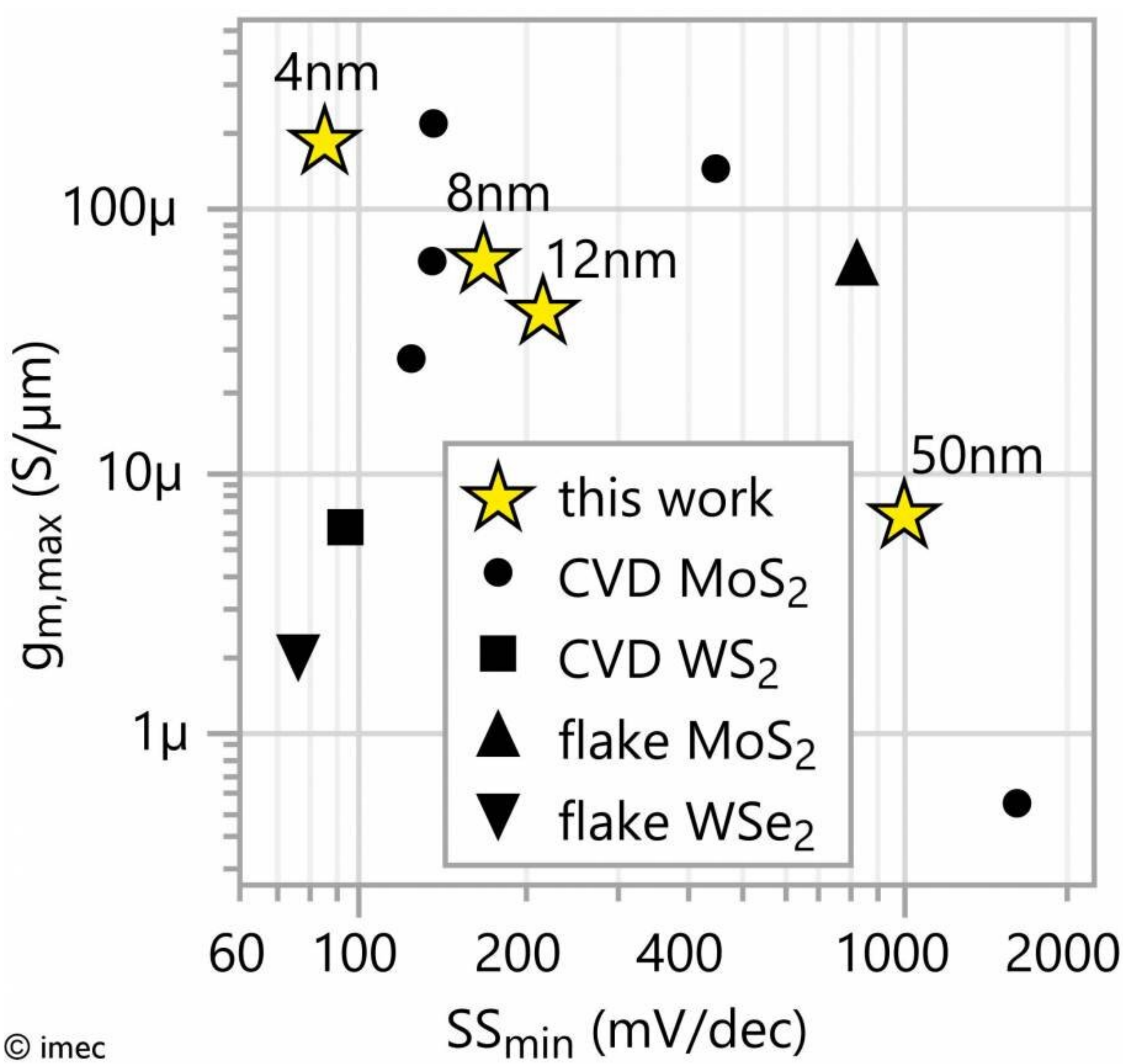
Imec shows excellent performance in ultra-scaled FETs with 2-D-material channel

December 9 2019, by Hanne Degans

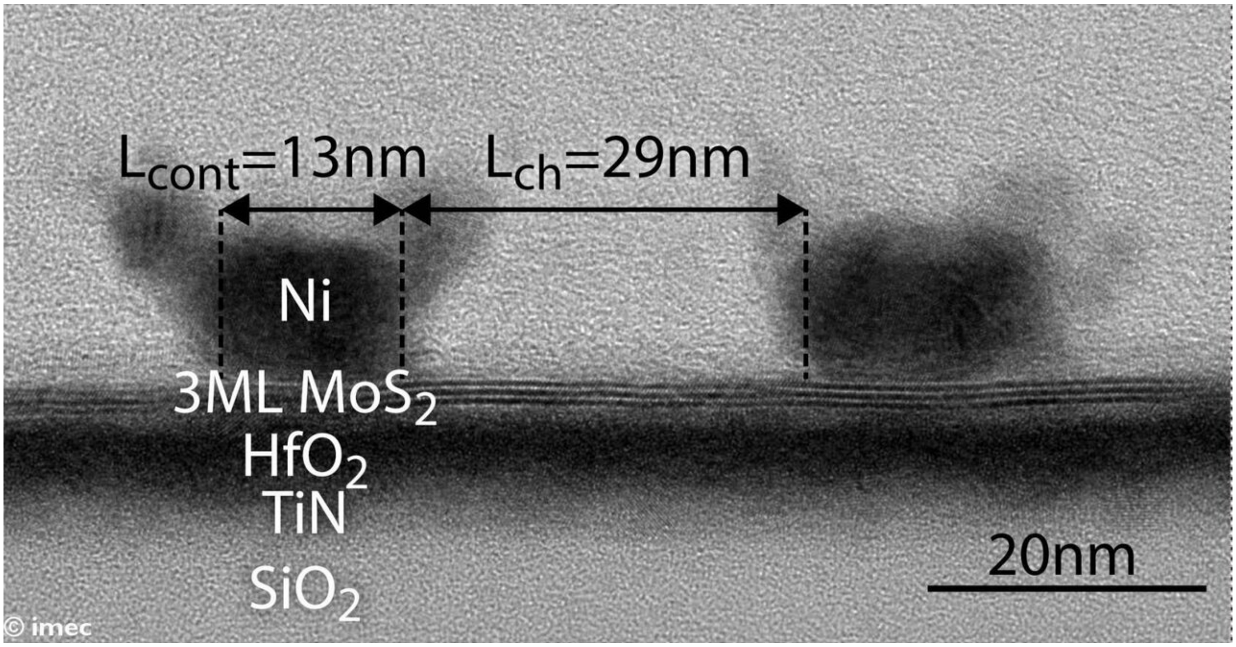


Benchmark study: imec's devices with 4nm, 8nm, 12nm HfO2 and 50nm SiO2 have excellent combination of gmmax and SSmin compared to literature. Credit: IMEC

At this year's IEEE International Electron Devices Meeting (Dec 7-11 2019), imec reports an in-depth study of scaled transistors with MoS_2 and demonstrates best device performance to date for such materials.

MoS_2 is a 2-D material, meaning that it can be grown in stable form with nearly atomic thickness and atomic precision. Imec synthesized the material down to monolayer (0.6nm thickness) and fabricated devices with scaled contact and channel length, as small as 13nm and 30nm respectively. These very scaled dimensions, combined with scaled gate oxide thickness and high K dielectric, have enabled the demonstration of some of the best device performances so far. Most importantly, these transistors enable a comprehensive study of fundamental device properties and calibration of TCAD models. The calibrated TCAD model is used to propose a realistic path for performance improvement. The results presented here confirm the potential of 2-D-materials for extreme transistor scaling—benefiting both high-performance logic and memory applications.

Theoretical studies recommend 2-D materials as the perfect channel material for extreme transistor scaling as only little short channel effects are expected compared to the current Si-based devices. Hints of this potential have already been published with one-of-a-kind transistors built on natural flakes of 2-D materials.



TEM pictures showing (a) 3 monolayers MoS2 channel, with contact length 13nm and channel length 29nm Transfer characteristics have improved sub-threshold swing (SS) with thinner HfO2. Credit: IMEC

For the first time, imec has tested these theoretical findings through a comprehensive set of 2-D-materials-based transistor data. The devices with the smallest footprint have a channel length of 30nm and

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