Atomic-scale processing of gate oxides on 2D TMDs for future transistors

Short description: You will investigate growth of metal oxides by ALD onto 2D semiconductor materials by atomic layer deposition.

Background: If you look at roadmaps of Intel and TSMC, it is clear that the next-generation semiconductor in transistors that will replace silicon are so-called 2D transition metal dichalcogenides (2D TMDs). These two tech companies both state that there are two key challenges for this transition to happen in the next decade:

1. Doping of the 2D material (n- and p-type)
2. Controlled growth of the gate oxide onto the 2D material.

In this project, you will look at the 2^{nd} aspect using atomic layer deposition (ALD), a technique that enables layer-by-layer deposition of thin films with atomic-level control of the film thickness.

Project: In this project you will investigate growth of metal oxides on 2D TMDs by ALD. The challenge lies in the fact that the 2D TMDs are chemically inert outside of the 2D plane, or in other words, the gases (precursors) used during ALD will have difficulty binding to the top of the 2D material. You will look at approaches to improve this, for example by exposing the 2D TMD to ozone, mild plasma's or other chemicals prior to ALD. This project will have a strong component of understanding if and how such approaches improve the ALD growth process (studied with in-situ techniques) and possibly affect the underlying 2D material.

In this project you will work with ALD and gain experience on working in a cleanroom facility. You will learn about important characterization techniques such as spectroscopic ellipsometry, Raman, X-ray photoelectron spectroscopy and atomic force microscopy.

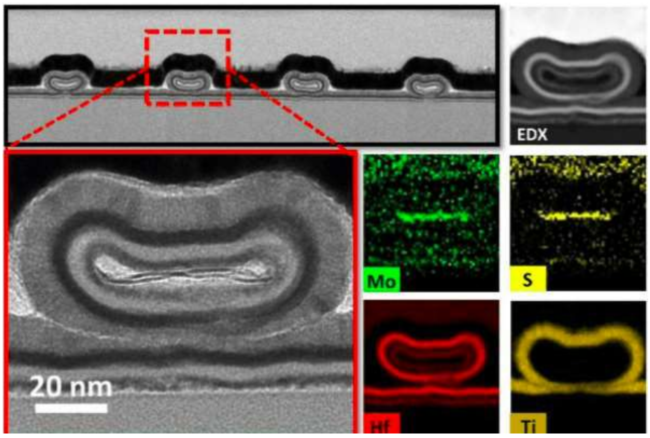

***Fig. 1:** Electron microscopy image of the world's first 2D nanosheet transistor as presented by TSMC at last year's IEDM conference in San Francisco. The active channel of the transistor is a monolayer of MoS2. Furthermore, you can see hafnium oxide as gate dielectric wrapped around the 2D material. In this project you will look at growth of such HfO_x (or other metal oxides).*

If interested please contact:

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Location and supervision: You will perform experiments in the cleanroom and labtuin that are located in Spectrum. You will be supervised by Bart Macco.