2D-TMDs as a Cu diffusion barrier, tested by time-dielectric breakdown tests

Short description: The possibility to use two-dimensional transition metal dichalcogenides (2D-TMDs) as a barrier layer in Cu interconnect structures could enhance the industry to further scale down chips.

Background: Further downscaling of electronics is limited by the scaling of (among others) copper interconnects. When copper thicknesses are getting below 100 nm, the resistivity increases exponentially. This becomes a problem when the thickness of the copper is also limited by other factors. In interconnect structures there is a so-called barrier layer present which prevents Cu diffusion from the Cu line to the underlying material (often a dielectric). This barrier layer also needs to decrease in thickness. The problem is, however, that the conventional barrier fail when the thickness comes below 3 nm. Finding a new barrier which will work at lower thicknesses is thus the challenge.

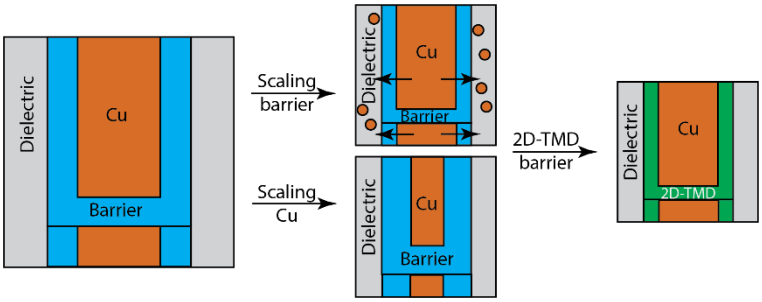

Figure 1. Challenges of interconnect scaling, either the barrier of the Cu needs to be scaled. Scaling the barrier leads to Cu diffusion and scaling the Cu leads to high resistivity. Replacing the conventional barrier with a 2D-TMD layer can solve this challenge.

The focus of this project is on exploring the possibility of using different 2D sulfides as a barrier layer, such as MoS_2. The technique to create these thin layers is atomic layer deposition (ALD), a technique that enables layer-by-layer deposition of thin films with atomic-level control of the film thickness. ALD has recently become an important element of the semiconductor fabrication toolbox and being a true, enabling nanotechnology it is gaining ever more attention. The goal of this project is to use different 2D sulfides as a barrier layer against Cu diffusion.

Project: The goal of the project is to find out how the different materials can act as a barrier layer in Cu interconnects. You will work on different measurement techniques to characterize the material, such as electron microscopy and XPS, and you will work with time-dependent dielectric breakdown (TDDB) measurements to characterize the barrier properties. Besides the characterization you will also deposit the layers yourself on a commercial ALD reactor.

Location and supervision: You will perform experiments in the cleanroom and TDDB measurement lab which are both located in Spectrum. You will work in the nanoelectronics ALD subgroup, which is led by Adrie Mackus. Your daily supervisor will be Sanne Deijkers.

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