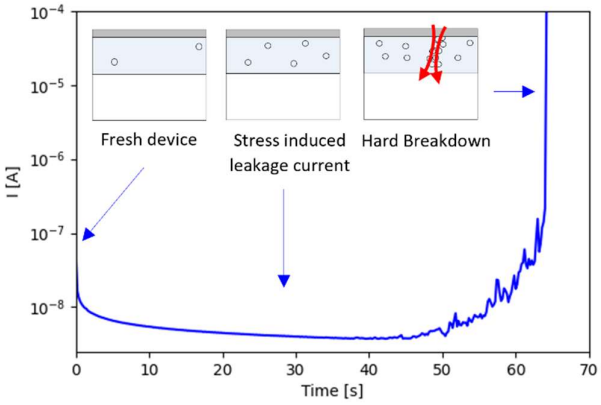
Reliability characterizations of high-k dielectrics used in advanced MIM capacitors

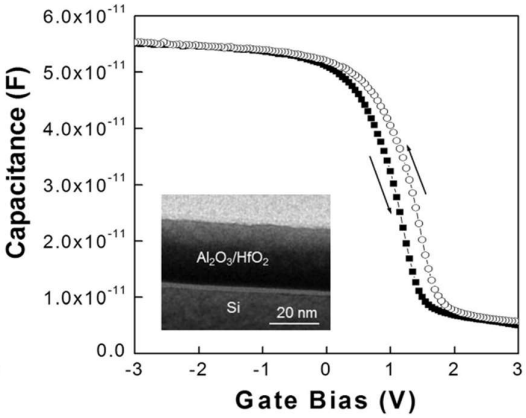
Metal–insulator–metal (MIM) capacitors are key components of advanced integrated circuits (IC). They are widely used to perform decoupling, filtering or RF functions. The constant search for more complex systems with ever increasing performances relies on a continual down-scaling of device dimensions. Consequently, shrinking the area occupied by MIM capacitors is essential while a constant increase of their capacitance values is required to maintain the decoupling performances in advanced nodes power delivery networks (PDN). Achieving larger capacitance densities, while preserving a minimal thickness to minimize the leakage current requires using high-k dielectrics with permittivity larger than 15 such as HfO_2 or ZrO_2. However, one of the key obstacles to high-k integration are the defects in these materials and the lack of understanding about their nature.

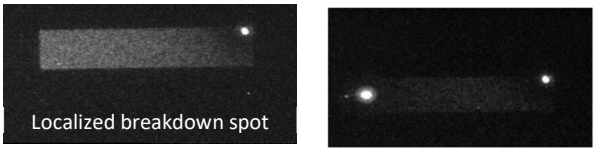
During this internship, Al-, Hf- and Zr-based high-k materials of various thicknesses and integrated in MIS stacks will be investigated. The project focuses on time-dependent dielectric breakdown measurements (TDDB - dc/ac) performed at various temperatures to determine the lifetime characteristics of dielectrics. For this, a constant voltage stress is applied while the leakage current is monitored. In that way, the acceleration and lifetime models are extracted to study the dielectric breakdown and degradation of the structures.
Furthermore, various monitoring measurements (C(V), C(f), transient currents...) will be performed while stressing the dielectrics to characterize the evolution of defects in these materials. The goal of the internship is to understand the nature and dynamics of the defects present in these materials.

The student will get an introduction to the basics of TDDB and the derivation of the acceleration- and lifetime models. Afterwards, the student will carry out TDDB measurements and other characterization techniques on MIS structures with different high-k materials. The data will be analyzed by the student and interpreted with the help of the supervisor.

If you are interested, please send an email including your motivation and a CV (or any other questions you may have) to corinna.fohn@imec.be. We look forward to hearing from you!







Nigro, Raffaela Lo, et al., 2016
Robin Degraeve, 2004

Required background: Material Sciences, Physics, Physics engineering or equivalent
Supervising Scientists: Corinna Fohn (corinna.fohn@imec.be), Emmanuel Chery (emmanuel.chery@imec.be)
Type of work: Literature (20%), Data analysis (30%), Experimental (50%)
Duration: 6 months, preferred start in October
Institution: imec, Kapeldreef 75, 3001 Leuven, Belgium