Applications of Al_2O_3 ultrathin films in electronic devices

Marco CANNAS - *University of Palermo*

The current research is stimulated towards new challenges such as the control of physical/chemical properties of nanomaterials and nanocomposites by engineering their size; altering their surface by doping and functionalization; and integrating them within specific devices in the fields of optoelectronics, photovoltaics, lasing.

Here we present some applications based on the use of ultrathin Aluminum Oxide (Al_2O_3), one of the most attracting insulating materials with relevant electronic properties: high relative dielectric permittivity ($\kappa \approx 9$), high critical electric field (10 MV/cm), large band gap ($E_g \approx 8.9$ eV).

The first application concerns with atomic layer deposition (ALD) of highly homogeneous Al_2O_3 films directly onto monolayer (1L) MoS_2 exfoliated on gold. This system evidences a better nucleation process than in the case of 1L MoS_2 supported by a common insulating substrate (Al_2O_3/Si), a uniform 3.6 nm film is indeed achieved after 80 ALD cycles. This high-quality ALD growth can find relevant applications, including the fabrication of FETs or the passivation of non-volatile switching memory devices based on Au/1L MoS_2/Au junctions.

The second case study derives from the use of Al_2O_3 film (16 nm) in AlGaN/GaN heterostructures. Time-dependent C-V characterizations and luminescence spectra allow to determine the maximum depth of the insulating layer interested by the negative charge trapping effect under reverse bias stress operation, the electron traps being associated with a fraction of oxygen vacancies in Al_2O_3. These results are useful to establish the thermal stability of the trapping phenomena, and the possible application in real devices.