ATOMIC LAYER DEPOSITION: LOW TEMPERATURE PROCESS WELL ADAPTED TO ULSI AND TFT TECHNOLOGIES

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The high k dielectrics is an important materials to be integrate in future Ultra Large Scale Integration (ULSI) and future TFT technology. Indeed, to keep on the Moore's Law curve, the reduction of silicon oxide (SiO_2) thickness still required, but this reduction is hindered by tunneling current leakage limit. Consequently, it is important to replace SiO_2 by another materials with high dielectric constant. The use of this material in manufacturing of gate dielectric in Thin-film transistor (TFT) and in Complementary Metal Oxide Semiconductor (CMOS) will increase gate capacitance with maintaining a low leakage current. Titanium dioxide is a good candidate due to its high dielectric constant in its rutile crystalline phase (180).This rutile structure is obtained at low temperature (250°C) by ALD deposition when TiO_2 is deposited on ruthenium dioxide (RuO_2) layer thanks to the small lattice mismatch between these two materials.

The major difficulty to get high TiO_2 dielectric constant is to find the optimized deposition conditions. In this paper, we report a study on the dependence of TiO_2 crystalline phase on the oxidant species used in ALD. Indeed, figure 1 show that using H_2O as oxygen source, anatase TiO_2 phase is obtained even when deposited on RuO_2 layer, while rutile phase is obtained when O_2 plasma is used as oxidant. Based on X-ray Photoelectron Spectroscopy (XPS) results, a chemical reaction scheme is proposed to explain the influence of oxidant species on TiO_2 phase. Moreover, in this paper another study will focus on the TiO_2 grain size and its influence on dielectric constant. Indeed, as shown in figure 2, two rutile structures were obtained with different dielectric constant that can be correlated to the average grain size. The influence of grain size will be discussed based on TiO_2 electrical characterization.

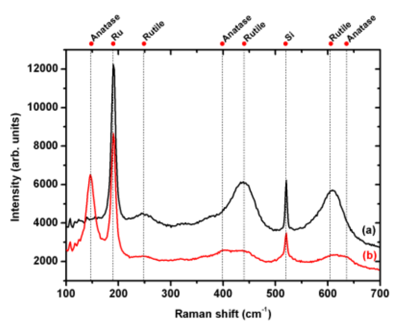

Figure 1. Raman spectra of TiO_2 grown by ALD at 250 °C using (a) O_2 plasma or (b) H_2O as oxygen source.

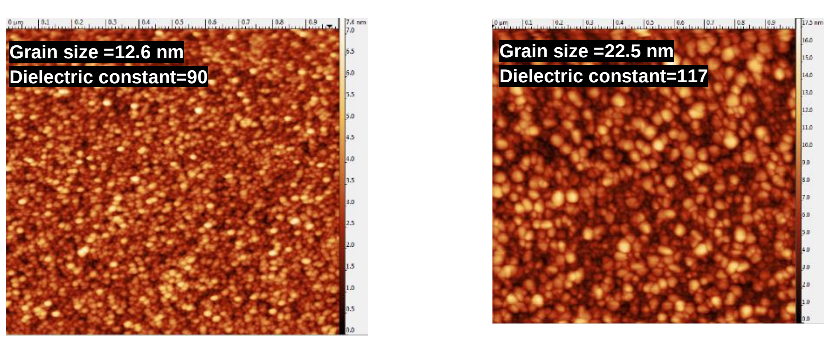

Figure 2. Influence of TiO_2 grain size on its dielectric constant