Characterization of Thermally Evaporated ZrO_2

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Zirconium Oxide (ZrO_2) as high-*k* gate dielectric has been under intense investigation recently for replacing conventional SiO_2 for its high dielectric constant (~20-25), low leakage current, and good thermal stability on silicon. Numerous techniques have been used to-date to grow this layer on silicon. Each technique has their own set of advantages and disadvantages. Thermal evaporation is known to be a rather gentle process that creates none or very little damage to the interface.

Zirconium oxide (ZrO_2) films were grown on p-type silicon wafers by using standard thermal evaporation of zirconium while adding oxygen at constant partial pressure during evaporation. Before evaporation, the wafers were cleaned using standard RCA cleans (RCA-1 and RCA-2) followed by a 50:1 HF dip for 15 minutes immediately before the deposition. ZrO2 of thickness as measured by ellipsometer of 59Å, 89Å and 173Å were deposited for the current work. Metal oxide semiconductor capacitance structure was achieved by using a mercury probe station. Samples were annealed at 550 and 650 C in the presence of forming gas.

Table-1 summarizes the physical thickness (t_{phys} in Å) of the as-grown and after annealing. The dielectric constant as measured by the CV technique is estimated to be around 36. CV measurements taken at 100kHz are summarized in fig.1. As may be seen in fig.1, the maximum capacitance seems to flatten out for the lower physical thicknesses, which might indicate presence of an interfacial oxide. Figure-2 summarizes the electrical versus physical thickness.

ACKNOWLEDGEMENT

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Table-1:

Samples	t_{phys} as-grown (Å)	t_{phys} 550C FGA (Å)	t_{phys} 650C FGA (Å)
1	59	49	49
2	89	72	70
3	173	150	146

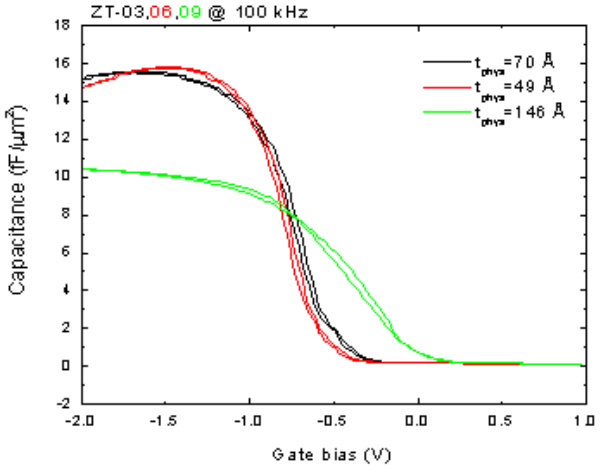

Fig-1: CV measurements taken at 100kHz

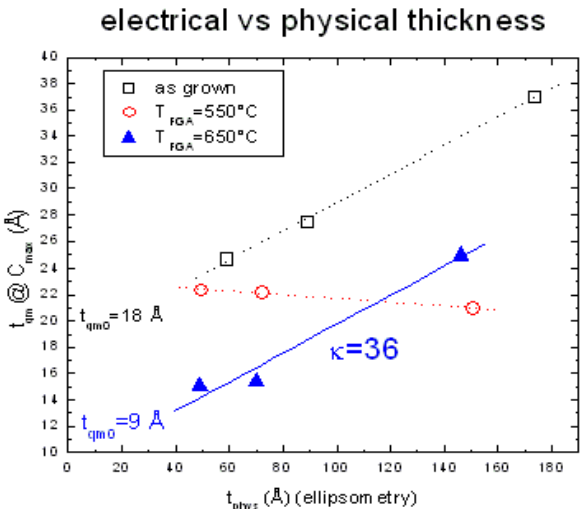

Fig-2: Electrical versus physical thickness