SOME PHYSICAL PROPERTIES AND COMPARISON OF ATOMIC LAYER DEPOSITED AND THERMALLY GROWN SILICON OXIDE

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Silicon oxide can be deposited from various sources using atomic layer deposition, but a comprehensive comparison of related resultant thin film properties is hard to find. A silicon source exploited, providing effective growth, has been organometallic compound hexakis(ethylamino)disilane (AHEAD) [1-3]. Oxygen source has been water, ozone or oxygen plasma.

In this work we compare some physical properties of SiO_2, such as density, refractive index, resistive switching, hardness and Young's modulus of ALD deposited thin films and a thermally grown one. Two different processes were used for ALD SiO_2 films. Thermal ALD process used AHEAD and ozone as precursors and O_2 plasma process used AHEAD and O_2 plasma. The ozone process was also characterized in more detail by using quartz crystal micro-balance.

As an example of the results, mechanical characterization using instrumented nano-indentation was performed. The thermally grown SiO_2 had about 25 % higher hardness and modulus compared to fused quartz glass (the calibration standard for the indentation device). The SiO_2 from AHEAD-ozone process on the other hand showed approximately 2-3 times lower hardness and 20-40 % lower modulus compared to fused quarts glass, somewhat depending on the ALD growth temperature. The difference these two SiO_2 films could indicate internal stresses in the films, which influence mechanical behaviour of materials.

From applications point of view, the internal stresses in layers used in a device or structure may not regarded as advantageous. For instance, if crystalline layered structures were sandwiched between such stressed layers, occasional relieve of the stress could affect the crystalline structure and cause device/structure malfunctions. Complementarily, other results like resistive switching properties will be reported.

References

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