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Sputter deposited Al₂O₃, SiO₂ and Si₃N₄ films for electrical insulation at high temperatures

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In the paper the breakdown field strength and resistivity of sputter deposited Al₂O₃, SiO₂ and Si₃N₄ layers are investigated in the temperature range between room temperature and 400 °C. Deposition is performed in an industrial type cluster sputter equipment. Deposition rates range between 2.5 and 4nm/sec. Insulation properties were measured on films with a thickness of 1µm on Si wafers. For both SiO₂ and Al₂O₃ films a breakdown field strength of 6 MV/cm and a specific resistivity of 10¹⁷ Ωcm was measured at room temperature. The yield of the insulation films with respect to a test voltage of 250, 500 and 800V was determined on single films and layer systems of Al₂O₃, SiO₂ and Si₃N₄ with a total thickness of 7µm on steel substrates. At room temperature the investigated layers exhibit a yield between 95% and 100% during test at 800V. At 400°C the yield at 800V ranges between 80 and 90%. The investigated layer systems show no better insulation yield then single layers at the same thickness, but are mechanically better adapted to the metal substrate. These temperature stable insulation layers find application in sensor, automotive and aviation technology. One presented example is the insulating layer that separates the metal membrane from the strain gauge in a pressure sensor.

Keywords

magnetron sputtering

pulse sputtering

Al₂O₃

SiO₂

Si₃N₄