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New approaches for improving isolation strength of magnetron sputtered dielectric films

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For sensor technology there is a demand for isolation films with a high breakdown voltage on large areas and temperature resistance as well as high bonding strength on different substrates. Physical vapor deposition (PVD), especially magnetron sputtering, already allows to deposit films fulfilling the requirements of a variety of applications. One limit of further increase of breakdown voltage however is the defect growth, which is inevitable associated with magnetron sputtering. Small particles or point defects during the film growth act as starting point of cone-shaped defect growing throughout the film. The experiments presented in this paper show new approaches to prevent or stop defect growing in Al_2O_3 films deposited by reactive pulse magnetron sputtering.
One approach of the improvement was to add in between the sputtered film a thin intermediate layer using atomic layer deposition, pulsed laser deposition or a PVD layer with enhanced ion bombardment. To enhance the ion bombardment during the sputtering process rf-bias was applied to the substrate. It was found, that especially an Al_2O_3 interlayer deposited by ALD improved electrical strength and specific resistance most.
Another approach was the study of co-sputtered $AlSiO_x$ nano-composite films. This material combines the higher temperature resistance and the higher isolation strength of SiO_2 with the advantageous mechanical properties especially stress and coefficient of thermal expansion of Al_2O_3. $AlSiO_x$ achieves a high isolation strength also on rough metal surfaces and was coated with a high deposition rate of 2 nm/s.
With both approaches an isolation film on a rough steel substrate with an electrical strength of 2000 V and a specific resistance higher $1x10^{15}$ Ω*cm was achieved. One example of the application of the film is a pressure sensor. This film fulfills the breakdown voltage of 2000 V required for explosion prevention in hydrogen technologies.

Keywords
pulsed magnetron sputtering
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electrical isolation
breakdown voltage