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Workshop 5 – Atomic Layer Deposition

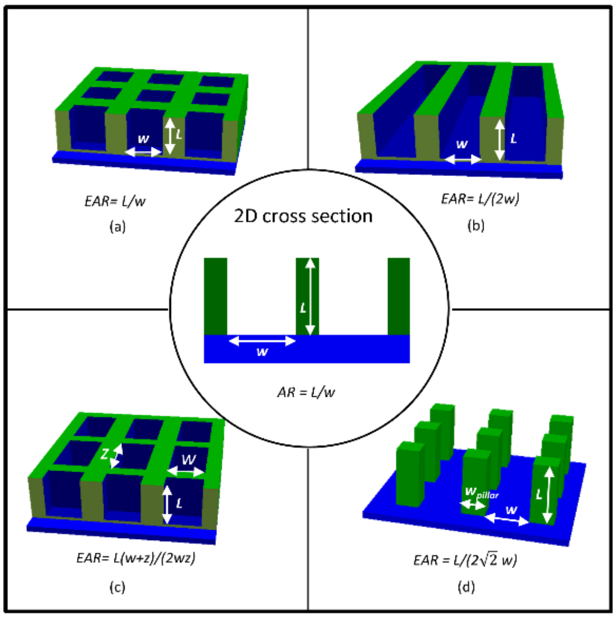
Conformality in Atomic Layer Deposition

Véronique Cremers[1,4], Riikka L. Puurunen[2,3], and Jolien Dendooven[4]

[1]Plasma Electronic, Otto-Lilienthal-Straße 2, D-79395 Neuenburg, Germany
[2]Department of Chemical and Metallurgical Engineering, Aalto University School of Chemical Engineering, P.O. Box 16100, FI-00076 AALTO, Finland
[3]VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland
[4]Department of Solid State Sciences, Ghent University, Krijgslaan 281/S1, B-9000 Ghent, Belgium

cremers@plasma-electronic.de

Atomic layer deposition (ALD) relies on alternated, self-limiting reactions between gaseous reactants and an exposed solid surface to deposit highly conformal coatings with a thickness controlled at the submonolayer level. These advantages have rendered ALD a mainstream technique in microelectronics and have triggered growing interest in ALD for a variety of nanotechnology applications, including energy technologies. Often, the choice for ALD is related to the need for a conformal coating on a 3D nanostructured surface, making the conformality of ALD processes a key factor in actual applications. A review of the current status of knowledge about the conformality of ALD processes will be given, including an overview of relevant gas transport regimes, definitions of exposure and sticking probability and a distinction between different ALD growth types observed in high aspect ratio structures. In addition, aiming for a more standardized and direct comparison of reported results concerning the conformality of ALD processes, a new concept is proposed, Equivalent Aspect Ratio (EAR), to describe 3D substrates and introduce standard ways to express thin film conformality. Other than the conventional aspect ratio, the EAR provides a measure for the ease of coatability by referring to a cylindrical hole as the reference structure.



The scheme in the central circle depicts the depth to width ratio (AR) as measured on a cross-section of a 3D feature. The surrounding schemes provide the Equivalent Aspect Ratio (EAR) taking into account the 3D geometry of square holes (a), trenches (b), elongated holes (c), and square pillars (valid for L/w in the range of 5–50 and $w/w_{pillar} = 3$) (d). The EAR in (d) was determined for molecular flow conditions