75 Word Abstract Format

Design and Proof of High Quality $HfAlO_X$ Film Formation for MOSCAPs and nMOSFETs through Layer-by-Layer Deposition and Annealing Process

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We propose a new method for high-k film growth and demonstrate its usefulness in terms of improvements of electrical characteristics of MOSCAPs and nMOSFETs. *Layer-by-Layer Deposition & Annealing* (LL-D&A) is a key concept to reduce impurities incorporated in the film and improve electrical properties for $HfAlO_x$ (Hf:75at.%). The residual carbon was 50% reduced in $HfAlO_x$ films grown through D&A(O_2). The excellent properties of D&A(O_2) $HfAlO_x$ such as a small δV_{FB} less than 0.06V for MOSCAP, a low subthreshold swing of 77mV/dec, a peak mobility of 210cm^2/Vs and 10-year lifetime at V_g=-1.9V for poly-Si gate nMOSFET were obtained.