Si (100) Nitridation by Remote Plasma for Enhanced High-κ Gate Performance

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Hafnium oxide is the leading high-κ candidate for next generation CMOS devices, however, the material has a propensity to react with the Si(100) substrate, to crystallize, and to have fixed and trapped charges leading to low transistor mobilities. To address the reaction with the substrate, a remote N₂/He plasma was used as a reactant during MOCVD with Hf (IV) t-butoxide which incorporates 6 at.% nitrogen located mostly at the film-substrate interface resulting in reduced interdiffusion upon anneal [1]. A new process for pretreating the silicon wafer with a N₂/He plasma was developed to improve nitrogen concentrations at the interface and reduce interdiffusion further. Films deposited with N₂/He plasma and the pretreatment method was compared to O₂/He plasma deposited films and N₂/He plasma deposited films without the nitridation step. It is shown that a 16Å interface SiNx layer is sufficient to prevent reaction during a 1000°C Ar/O² anneal at atmosphere and an intermediate annealing step is crucial for desired reduction in interdiffusion. Thick films show some crystalline peaks by XRD which are suppressed using the N₂ process. Electrical measurements on thick films show the pretreatment process results in the lowest leakage current density and the highest dielectric constant of 21.5.