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Applications of Atomic Layer Deposition (ALD) on ultra-fine pitch pixel detectors

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Atomic Layer Deposition (ALD) method is a derivate of more commonly adopted Chemical Vapor Phase Deposition (CVD) thin film growth methods. The deposition of a film by ALD is based on the successive, separated and self-terminating gas–solid reactions of typically two gaseous reactants. Separation of the reactants is accomplished by pulsing a purge gas (for instance oxygen, nitrogen or argon) after each precursor pulse to remove excess gaseous precursor from the process chamber prior the following deposition cycle. ALD is known as a method producing pinhole-free thin films due to its self-limiting surface chemistry growth mechanism. The ALD grown thin films, such as hafnium oxide (HfO_2) or tantalum oxide (Ta_2O_5), have high dielectric constants compared thermally oxidized silicon (SiO_2). In particle physics applications, the cell size of pixel detectors is trending to decrease, while leakage current due to radiation defects increases. Thus, it would be favorable to isolate capacitively the DC leakage current from the input of the readout ASIC. In this case, ALD grown dielectric films could be used as capacitive coupling (AC-coupling) layers due to their potentially high capacitance density. Furthermore, with ALD it is possible to engineer oxide and interface charge type and density at dielectric-silicon interfaces. We present measurement results and simulations of different radiation detector structures with ALD grown dielectric films. Our results, obtained with Photoconductivity Decay (PCD) method, indicate surface passivation properties comparable with thermally grown SiO_2.

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