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Plasma Energetic in Pulsed Laser Deposition and Pulsed Electron Deposition[1]

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Surface bombardment by energetic particles strongly affects thin film growth and allows surface processing under non-thermal equilibrium conditions. Deposition techniques enabling energy control can effectively manipulate the microstructure of the film and tune the resulting mechanical, electrical and optical properties. At the high power densities used for depositing stoichiometric films in the case pulsed ablation techniques such as Pulsed Laser Deposition (PLD) and Pulsed Electron Deposition (PED), the initial energetic s of the material flux are typically in the range of 100s of eV, much higher than the optimal values ($\leq$ 10 eV) required for high quality film growth. To overcome this problem and to facilitate particle energy transformation from the original as-ablated to the one optimal for film growth, one needs to carefully select the ablation conditions, conditions for material flux propagation through a process gas (or vacuum)and location of the growth surface (substrate) within this flux. In this talk, I will discuss the energetics of the propagating materials flux in the case of PLD and PED, and identify parameters that require critical control for realizing optimum thin film growth. As an example, growth optimization of epitaxial GaN films is provided. PED is complementary to PLD and exhibits an important ability to ablate materials that are transparent to laser wavelengths typically used in PLD. Some examples include wide band gap materials such as SiO2, Al2O3, MgO etc. Both PLD and PED features can be integrated within a single deposition module. PLD-PED systems enable in-situ deposition of a wide range of materials required for exploring the next generation of complex structures that incorporate metals, complex dielectrics, ferroelectrics, semiconductors and glasses.

[1]In collaboration with Mikhail Strikovski, Neocera, LLC.