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Direct Metal Ion Beam Deposition and its Applications

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Direct metal ion beam deposition (DMIBD) is recently recognized as a very promising new thin film technique. DMIBD is defined as the deposition of materials as an ionic species in the energy range of 1.0 to 300eV. This energetic non-thermal equilibrium deposition process produces films by "Kinetic Bonding / Energetic Condensation" mechanism not governed by the common place thermo-mechanical reaction. The DMIBD process differs fundamentally from the conventional ion beam assisted deposition (IBAD) technique such that the ion beam energy transfer to the deposition process is directly coupled the DMIBD process.

Since the DMIBD process is forming materials with high kinetic energy of metal ion beams, the process provides following unique advantages: (1) to synthesize non thermo-equilibrium materials, (2) to form materials at lower processing temperature, (3) to deposit very uniform, dense, and good adhesive films.

Novel metal ion sources have been developed for the DMIBD process. The patented metal ion source is capable of producing variety of metal ion beams such as C, Si, W, Ta, Mo, Al, Au, Ag, Cr etc. Using the novel metal ion source, successful results were obtained in several applications: (1) For the amorphous diamond like carbon films, superior quality films : hardness of about 50-60 Gpa, transparent, wear resistance less than 10^{-8} mm³/Nm, sp³/sp² ratio of ~90%, and atomically smooth films (<1nm Ra) were obtained at an optimum ion beam energy of 100-150eV. (2) High hardness carbon nitride films were formed and the formation of single bonded C-N is strong function of ion beam energy. (3) A cesiated amorphous diamond thin film coated Si surface exhibits negative electron affinity characteristics. Turn-on voltage is observed as low as 10V/μm even in the planar geometry. This novel structure is extremely feasible to flat panel display. (4) Low energy ion beam (~100eV) provided a uniform surface modification for the hetero-epitaxial diamond films.

In this presentation, the principles of DMIBD and several applications of negative metal ion source will be introduced. The negative metal ion sources are currently commercialized through SKION Corporation.