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Development of Pulse-Operated Penning Plasma Source for High-Speed Physical Vapor Deposition

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A pulse-operated penning plasma source has an instantaneous power of several tens of kilo-watts and an order of the current density of A/cm2 class, of which characteristics are similar to so-called HiPIMS glow plasma. The magnetic field is perpendicular to the target surface thoroughly and the plasma generation can be set arc-free and no-droplets. These characteristics are superior to the conventional magnetic sputtering system. The parallel magnetic field line would be easy to know plasma characteristics by using a global simulation based on the electron-collision dominant reactions. We are aiming the pulse-operated Penning plasma generation system to apply a small scale PVD system for semi-conductor manufacturing system such as minimal fab system. This plasma generation system is also featured to be easily for scaling up the PVD deposition system. From these two points, we believe that the Penning glow plasma source is promising the new deposition system. In this study, we obtained the fundamental plasma characteristics by a simulation model. After that, we prepared aluminum thin film on silicon substrate with 1.5 micro-meter/h high-deposition rate.

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