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# Titanium nitride deposition by reactive high-power pulsed sputtering Penning discharge

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High power pulsed sputtering (HPPS) is the method of obtaining metallic plasma by applying negative high voltage pulses with peak power higher enough than the electric power used by DC sputtering to a cathode. On general HPPS discharge, the magnetron type cathode is used. In this case, the magnetic field is configured across the electric field around the cathode. Against this, we use a Penning discharge type target cathode. HPPS Penning discharge is featured that the plasma is generated at a space consisting of a pair of cathodes as sputtering target (W24×H20×t5) in parallel each other. Distance between targets is 10 mm. The chamber wall works as an anode to collect electrons. The electric field is parallel to the magnetic field at the gap. The magnetic field is provided by setting a set of permanent magnets (ø14×17, NdFeB) behind the targets. Energetic argon ions accelerated by a voltage difference between the cathode and the plasma are bombarded to the sputter target, and emit the metallic target atoms and secondary electrons. Secondary electrons are confined between the two targets by magnetic field and electrical potential wall, ionize the target atoms, and improve the metallic plasma density. Therefore the metallic plasma flows out to the deposition area. We generated HPPS Penning discharge plasma under argon/nitrogen mixture gases, and tried deposition of the titanium nitride thin film. The voltage pulse train of -800 V was applied to the titanium sputter target at the repetition rate of 400 Hz under the ambient argon/nitrogen mixture gas of the flow rate of 20 sccm and the gas pressure of 0.8 Pa. The collector electrode was floating electrically. When the mixing ratio was 25% or less, nitrogen gas did not much influence film forming velocity. The deposition rate increased with the pulse duration. In comparison with only argon, the deposition rate in nitrogen ratio of 30% decreased 22% around the pulse duration of 80 μs, and decreased 71% around 40 μs.

**Keywords**
Pulsed sputtering
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