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## **Hairpin probes diagnostic of the magnetized magnetron plasma operating in several operation modes**

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The magnetron discharges are widely used for industrial applications mainly for metallic and metal compounds thin film deposition. These discharges are very versatile and can be operated in DC, pulsed DC, RF boosted DC driven – so called RF-IPVD and also HiPIMS (High Power Pulsed Magnetron Sputtering). Depending on the excitation mode, the plasma density varies from  $10^{14}$  to  $10^{18}$  m<sup>-3</sup>. Beyond this large range of plasma densities that makes difficult to use conventional electrical probes, the presence of strong magnetic fields especially close to the cathode – the most interesting region – induces serious drawbacks about these probe measurements. Moreover, the high deposition rate of metal can drastically affect the probes operation. To overcome most of these weak points, the hairpin probes proved in the later years their effectiveness as alternative technique for measuring the plasma density. Indeed, the hairpin measurements are not affected by weak magnetic fields and recent experiments have demonstrated that the effect of the uniform strong magnetic field can be easily accounted for and hence the true plasma density determined. Hence, we tested for the first time the hairpin as a suitable diagnostic technique for measuring plasma density in magnetized plasma region of the magnetron discharges.

The measurements were performed close to the target, in the magnetic trap where the magnetic field intensity is in the range of 800 – 1300 Gauss. Two probe configurations have been used; first parallel and second perpendicular, respectively the position of the hairpin prongs with respect to the coaxial transmission line. Combining these two configurations we can study the effect of both parallel and perpendicular magnetic field components on the hairpin probe measurements. Moreover, by the subtraction of these two measurements, one can determine the magnetic field gradient in z direction (perpendicular to the target) with a resolution given by the probes separation.

### **Keywords**

magnetron

microwave resonance probe

HiPIMS