

New Plasma Power Supply Technologies with Positive Reverse Pulsing

Increased Film Density for Magnetron Sputtering for conductive and on non-conductive substrates

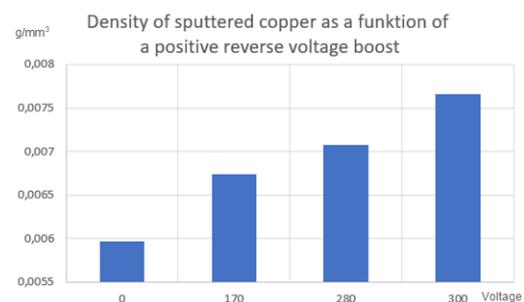
It is well known that with increasing content of ionized sputtered material the film density will be significantly increased [1]. Higher material density in a sputtered film always results in a better film quality, eg. hardness, optical properties, film smoothness, sheet resistance etc...

For ionized magnetron sputter depositing such as HiPIMS, a Bias Voltage can be applied to the conductive substrate to accelerate and attract ions. Thus, densifying the freshly formed film. This is commonly used for superior thin film requirements as in hard coatings eg. for machining processes, for optical or tribological coating applications.

A relatively new way of achieving an even higher density in HiPIMS films is by applying a short positive reverse voltage to the magnetron just after the negative pulse. This voltage pulse drives the present ions to the substrate. If this pos. voltage is adjustable the ion enhancement procedure can be controlled and regulated. This has been proven and shown in many studies and is used in the new generation of high-end HiPIMS-PS such as the **hiP-V HiPIMS** product line. Here the pos pulse is called **hiPlus**. It opens room for more enhanced process improvements due to high flexibilities of adjustments.

For any pulsed DC, HiPIMS and non-HiPIMS, a high intensity of rel. highly energetic ions is existent for several μ s after the neg. pulse [2]. Considering this, makes an ion enhanced processing also possible for non HiPIMS, pulsed DC processing. The new "Asymmetrically Bipolar Pulsing Power Supply", the **PLASMA TEC Ap**, offers completely new possibilities of reverse pulsing parameter settings. Positive reverse voltage pulses, let us call it the ion boost voltage, can be individually applied and set in voltage, power and of course for pulse-length and pulse-delay time. The **PLASMA TEC Ap** is an evolution of the existing **PLASMA TEC** power supply platform, manufactured by J.Schneider Elektrotechnik. Unique for the **PLASMA TEC** product line is the CFC Technology (Current Fed Converter). This means that the systems are fully current controlled, which is most advantages in arc sensitive processes. This opens complete new windows for process improvements of delicate and temperature sensitive materials such as medical and sensor applications, or AM (additive manufacturing) parts. It combines the advantages in magnetron sputtering of ion enhanced HiPIMS processing with the considerable higher deposition rate of DC-Pulsing with a demanding arc-handling. This also for non-conductive substrates.

It has been shown in a recent work with the **PLASMA TEC Ap** on a polyimide substrate by the Fraunhofer IGB, in Stuttgart Germany, that a pos. ion boost voltage of just 300V shows already an increase in film density of sputtered copper by 30%. This so-called boost voltage can be adjusted up to 1,2KV. A truly fortunate side effect of this applied ion boost voltage is a significant higher layer adhesion to the substrate.



Both plasma power supply developments with this positive reverse pulse voltage, the **PLASMA TEC Ap** and the **HiPIMS hiP-V** have been initiated by- and are available through **4A-PLASMA®**, an engineering consultancy for Plasma Power Technology.

For more information about this technology contact info@4A-PLASMA.eu.

[1]. K.-H. Müller; Phys. Rev. B 35, (1987) 7906

[2]. Physics and phenomena in pulsed magnetrons: an overview, J W Bradley^{1,3} and T Welzel², ¹ Department of Electrical Engineering and Electronics, The University of Liverpool, Brownlow Hill, Liverpool L69 3GJ, UK. ² Chemnitz University of Technology, Institute of Physics, D-09107 Chemnitz, Germany