

# High Power Impulse Magnetron Sputtering; An overview of history, properties and current status

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In plasma-based deposition processing, the importance of low-energy ion bombardment during thin film growth can hardly be exaggerated. Ion bombardment is an important physical tool available to materials scientists in the design of new materials and new structures. Glow discharges and in particular, the magnetron sputtering discharges have this advantage that ions present in the plasma are abundantly available to the deposition process. However, the chemistry at the substrate is usually dominated by the ions of the inert sputtering gas while ions of the sputtered material are rare. Over the years, various ionized sputtering techniques have appeared that can achieve a high degree of ionization of the sputtered atoms, often up to 50% and in some cases even as much as approximately 90%. This opens a completely new perspective in the engineering and design of new thin film materials. High power impulse magnetron sputtering (HIPIMS or HPPMS) is a relatively newly developed technique, which relies on the creation of a dense plasma in front of the sputtering target to produce a large fraction of ions of the sputtered material. In HIPIMS, high power pulses with a length of ~100  $\mu$ s are applied to a conventional planar magnetron. The highly energetic nature of the discharge, which can involve peak power densities of several kW/cm<sup>2</sup>, creates a dense plasma in front of the target, which allows for a large fraction of the sputtered material to be ionized. HIPIMS was introduced by Vladimir Kouznetsov in the mid 90's (see for example US patent 6296742), and has since then been investigated by an increasing number of academic groups. The technology is now taking its first steps into industrial applications. This presentation gives an overview of the history, physical properties and current industrial status of HIPIMS.

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**Topic: Hard Coatings**