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High Power Density Pulse Magnetron Sputtering - Process and Film Properties

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In this paper the changes regarding process and film properties in pulse magnetron sputtering will be discussed that occur in case of enhancing the power to high and very high power density until HIPIMS. The discharge current density was varied between 0.2 and 3.5 A/cm^2. The pulse mode (unipolar and bipolar) and the power density in the discharge influence plasma density and excitation of particles. This had been investigated using plasma emission spectroscopy. As a consequence of the different plasma conditions significantly different temperature rise of the substrate had been observed for samples having the same film thickness. The magnetron magnetic field strength is an important factor influencing the process behavior especially in HIPIMS. Methods of reactive process control in the transition mode will be considered that are advantageous for HIPIMS according to our evaluation. Ideas for upscaling of the HIPIMS process will be discussed.
On the examples of ZrN, Ti and TiO_2 the typical effects and their influence on film properties occurring during the transition from classical medium frequency pulse magnetron sputtering to high energy pulse sputtering (HIPIMS) will be described. Furthermore the influence of rising ionisation on the occurrence of crystalline phases and on mechanical, optical and photocatalytic properties of the layers will be presented.
The paper concludes with a placement of the processes related to other PVD-processes that is based on further own experimental results and evaluation of dependencies as well as considering published results of other groups regarding pulse magnetron sputter processes of high power density for the deposition of hard coatings and TCO.

Keywords
HIPIMS
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ZrN
TiO2