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## Two pulsed magnetron systems – characterization and application

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High-power pulsed magnetron sputtering of zirconium was investigated at a high average target power density in a period, being approximately 100Wcm$^{-2}$. The depositions were performed using an unbalanced circular magnetron with a directly water-cooled planar zirconium target of 100mm diameter. The repetition frequency was 500Hz at duty cycles ranging from 4 to 10% and an argon pressure of 1Pa. High fractions (21-32%) of doubly charged zirconium ions at rapidly decreasing fractions (from 23 to 3%) of singly charged zirconium ions were found in total ion fluxes onto the substrate (located d=100mm from the target), when the average target power density in a pulse increased from 0.97 to 2.22kWcm$^{-2}$. The enlarged target power densities during shortened voltage pulses resulted in a decrease of the deposition rate of films from 590 to 440nm/min at a weakly decreasing ionized fraction (from 55 to 49%) of sputtered zirconium atoms in the flux onto the substrate. For d=200mm, the doubly charged zirconium ions have become strongly predominant (up to 63%) in the total ion flux onto the substrate.

Hard (22 - 24 GPa) amorphous Si-B-C-N coatings with high thermal stability and oxidation resistance (even above 1500°C) were deposited on various substrates by pulsed dc magnetron sputtering using a single $B_4C$-Si (25:75%) target in an Ar-$N_2$ (50:50%) gas mixture. The substrate temperature of 350°C and the total pressure of 0.5 Pa were held constant during the depositions on the substrates at a floating potential or an rf induced bias of -100 V. A planar rectangular (127 x 254 mm$^2$) unbalanced magnetron was driven by a pulsed dc power supply operating at the repetition frequency of 10 kHz and the average target power over a period of about 500 W with 50% and 85% duty cycles. A very smooth surface morphology of the as-deposited coatings was achieved. Prior to deposition, a modification of the substrate surfaces was performed by pulsed magnetron sputtering of the $B_4C$-Si target in Ar gas at the same pressure, the duty cycle of 20% and the average target power over a period of about 250 W, the substrate temperature from 350°C to 480°C and the rf substrate bias of -1300 V for 12 min to enhance adhesion of the deposited Si-B-C-N coatings to various substrates.

**Keywords**
HiPIMS
Deposition characteristics
Si-B-C-N coatings
Improved morphology
Enhanced adhesion