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High Power Impulse Magnetron Sputtering of ZrH2 and Zr Films

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The refractory metal zirconium exhibits a high affinity to hydrogen, which results in the formation of hydrides such as ZrH_2.
We have deposited ZrH_2 and Zr thin films by high power impulse magnetron sputtering (HiPIMS) and direct current (dc) magnetron sputtering from a zirconium target in hydrogen-containing plasmas on Si(100) substrates, using the Linköping CC 800®/9 ML industrial-scale high-vacuum system from CemeCon AG. The growth was carried out either in pure Ar plasmas, partial pressure 0.42Pa, or plasmas containing: 2.5, 5, 10, 15, and 20% H_2 as seen from the resulting total pressure. A fixed target to substrate distance of 7cm and no external heating was applied during growth. The dc sputtered films were deposited for 120 s with the target operated at a power of 5 kW and at a substrate bias of -80 V. Growth by HiPIMS was carried out for 496 s with the pulse repetition frequency set to 300 Hz at a pulse width of 150 µs, using an average power of 3 kW and setting the substrate bias to -80 V.
X-ray diffraction shows that predominantly 111-oriented cubic-phase (δ) ZrH_2 films are grown by both techniques and for the most hydrogen-rich composition. For lower H_2 concentration, the diffraction patterns show traces of metallic zirconium in the dc sputtered films, whereas it is possible to retain the growth of 111-oriented δ-ZrH_2 films at lower H_2 concentrations, down to 5%, by HiPIMS. Diffractograms recorded from pure Zr references show that these films exhibit a 10$\bar{1}$0 preferred orientation both for the dc sputtered and the HiPIMS grown films.
Results from transmission electron microscopy, elastic recoil detection analysis, four point probe measurements, and pole figure measurements will be presented.

Keywords
HiPIMS
ZrH2
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Zr
H2