The possibilities for new metal oxide based materials is forever growing with the introduction
of novel deposition methods which allow precise control of the deposition parameters and the
ability to dope in order to tailor properties. The conditions used for the deposition of these
coships has an influence on the microstructure which in turn plays an important role in
determining physical properties, such as the optical transmission and electrical conductivity. In
addition, for many metal oxide materials the structure-property relationship is not well
understood. In this work, filtered cathodic arc (FCVA), DC magnetron sputtering (DCMS) and
high power impulse magnetron sputtering (HiPIMS) were utilised to reactively grow metal
oxide coatings (HfO₂ and ZnO) within an oxygen atmosphere.

FCVA deposition is a scalable energetic growth technique which allows for the synthesis of
nanoscale coatings with tuneable properties. In this technique, a conductive target material (in
this case, our metal) is ablated with a low voltage/high current electron flux. The metal ions
are directed through a magnetic double bend towards the substrate through an oxygen
environment. FCVA utilises a fully ionised plasma in which the energy of deposition can be
controlled by applying an electrical bias to the substrate, heating or by modifying the
processing pressure [1]. Thin film coatings grown using FCVA have been shown to have a low
rms roughness and a high density [1], which is ideal for device applications. DCMS (low energy
neutrals) and HiPIMS (high plasma density) were also selected to grow coatings. In
conventional DCMS, inert gas ions (such as argon) are accelerated towards a negatively biased
target material. When the target is sputtered, the target material is ejected and forms a thin
film coating on the substrate placed nearby within the vacuum. HiPIMS is a technique based on
magnetron sputtering, but unlike magnetron sputtering, HiPIMS, uses extremely high power
density pulses, achieving a greater ionisation of the sputtered material during deposition [2,3].

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Fig. 1: Cross sectional TEM bright field image of a Zn$_{1-x}$MgxO film with compositional variations through the thickness.

Fig. 2: Cross sectional TEM dark field image of the same region from figure 1 highlighting cubic MgO (100) planes.

Fig. 3: EELS areal density line scan of the marked region in figure 1, taken from the Zn and Mg core loss edges.