Thin-film deposition of mixed-conducting ceramic membranes

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Mixed ionic-electronic conducting ceramics are promising materials for the production of high purity oxygen. Oxygen atoms diffuse through the crystal lattice of these materials, allowing fully dense membranes to separate oxygen with theoretically infinite selectivity. However, the large activation energies involved generally necessitate high temperatures (~1000°C) for operation.

Thin films of these membranes are expected to display improved oxygen conductivity, due to their reduced diffusion path. This may allow separation to be carried out more rapidly and/or at lower temperatures. We have been developing anodic alumina templates as a supporting substrate for ultra-thin ceramic membranes. These templates feature hexagonally-packed collinear nanopores, and are stable up to temperatures of 800°C.

Yttria-stabilised zirconia (YSZ) and ceria gadolinium oxide (CGO) were deposited onto anodic alumina substrates by electron beam evaporation of the parent materials. Continuous films 200-400 nm thick were confirmed through SEM and XRD analysis. It was found that the substrate temperature during deposition strongly influenced the structure and stability of the films, with the desired cubic structure being retained at deposition temperatures above 450°C.

We are generalising this approach to the perovskite-type oxides, many of which are useful materials for oxygen separation. The synthesis and characterisation of a doped $SrCoO_{3-\delta}$ cubic perovskite will be discussed, with a view to its potential use as a bulk or thin-film separation membrane.