Self-supported ceramic substrates with directional porosity by mold freeze casting

Manufacture of thin-film ceramic substrates with high permeability and robustness is of high technological interest. In this work thin (green state thickness ~500 μm) porous yttria-stabilized zirconia self-supported substrates were fabricated by pouring stable colloidal aqueous suspensions in a mold and applying directional freeze casting. Use of optimized suspension, cryoprotector additive and mold proved to deliver defect free ceramic films with high dimensional control. Microstructure analysis demonstrated the formation of desirable aligned porosity at macro-structural scale and resulted to be highly dependent on colloidal behaviour and freeze casting conditions. Manufactured green films were joined by lamination at room temperature and sintered to obtain symmetrical cells consisting of two porous self-supported substrate electrodes (~420 μm) and dense yttria stabilized zirconia electrolyte (~10 μm).