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# Atmospheric pressure plasma enhanced CVD of high quality silica-like bilayer encapsulation barrier films

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Atmospheric pressure-plasma enhanced chemical vapour deposition (AP-PECVD) is an innovative technology that can be integrated into many existing manufacturing systems to facilitate the mass production of functional films. To date, roll-to-roll AP-PECVD has been successfully used to produce ultra-smooth, 100 nm single layer silica-like thin films that demonstrate good water vapour barrier performance, therefore showing particular promise as a technique in the field of protective layer synthesis for flexible organic solar cells. However, this technology is only viable for encapsulation barrier production if high quality films can be manufactured at high throughput and at low cost. The generation of bilayer silica-like thin films comprising a dense ‘barrier’ layer synthesised using very low precursor gas flows and a porous ‘buffer’ layer synthesised at a high deposition rate, could provide one potential solution to this scientific and industrial challenge.
A glow-like dielectric barrier discharge in a roll-to-roll set-up was used to deposit a series of bilayer silica-like thin films composed of a ~60 nm buffer layer and a 2–30 nm barrier layer onto a polyethylene 2,6 naphthalate substrate by means of AP-PECVD. In each case, the deposition conditions for the buffer layer were kept constant, while the conditions for the synthesis of the barrier layer were varied in order to study the effect of barrier thickness and input energy per precursor gas molecule on the chemical composition and porosity of the barrier layer and hence, the influence of this layer on the encapsulation barrier performance of the overall film. The analysis provided valuable information concerning the structure of the silica network within each barrier layer, and hence the influence of the input energy per precursor gas molecule, film thickness and ultimately the process throughput, on the final film quality.

**Keywords**
AP-PECVD
Encapsulation barrier
Silica
Bilayer