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Development of nanostrucutred advanced barrier hybrid films for organic electronics encapsulation in a continuous roll-to-roll process

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The lifetime stability of emerging organic optoelectronic devices is of major importance, due to the sensitivity of organic molecules and cathode metals to moisture and oxygen. For flexible OLED and OPV devices the target characteristics of barrier film coatings are flexibility, low weight, high transparency, low levels of water vapor transmission rate (WVTR) and oxygen transmission rate (OTR) and low cost production, with requirements for OLED lifetimes of 9000 hours implying WVTR of <1E-6 $gm^{-2}day^{-1}$ and OTR of <1E-3 $cm^3m^{-2}day^{-1}$. Transparent polymeric barrier materials have some limitations since they have high permeability of oxygen and moisture.
Several barrier structures approaches have been proposed in order to reduce the permeation rate of vapour through the polymeric substrate, with the hybrid metal-oxide/polymer layer films being the more successful to date, building a multilayered structure of polymer/metal oxide/ polymer films, stacking alternated polymer and inorganic layers. The more common approaches apply multilayer hybrid structures of SiO_X/acrylate polymer, Al_2O_3/acrylate polymer or ZnO/acrylate polymer. In this work we present an Al_2O_3/acrylate polymer multilayer barrier coated onto a PEN substrate, with good mechanical (flexibility) and adhesion properties between inorganic and organic layers, extremely low permeation rate to oxygen and water vapour and high optical transparency. The acrylate polymer thin film is coated using Polymer Multilayer deposition technologies and the Al_2O_3 thin film is coated using DC reactive sputtering technologies. Both deposition processes are in-line, enabling a continuous roll-to-roll deposition process. The thickness of each film, number of organic/inorganic layers, morphology, optical transmission and mechanical properties of the multilayer are addressed with the objective of achieving a synergistic optimization of optical, mechanical and permeability properties of the overall structure.

Keywords
High barrier Coatings
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High optical transparency coatings