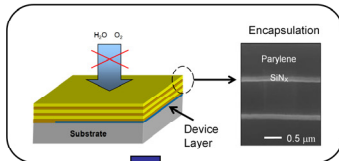




Barrier coatings for organic electronics

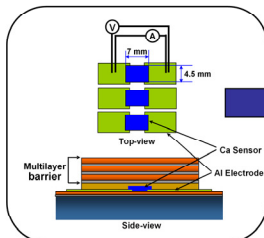


Barrier coating architecture:

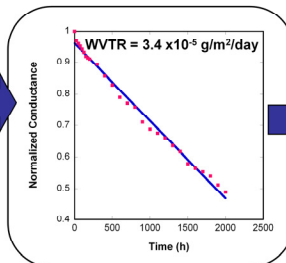


ACHIEVEMENTS: Thin-film barrier coatings based on SiN_x and parylene have been integrated with organic solar cells. Effective water vapor transmission rates (WVTR) have been determined using Ca tests as a function of the number of organic/inorganic bi-layers. WVTR values as low as 3.4×10^{-5} g/m²/day were obtained. This encapsulation technology was validated on organic solar cells, and shelf-lifetimes of 2,500 h could be demonstrated.

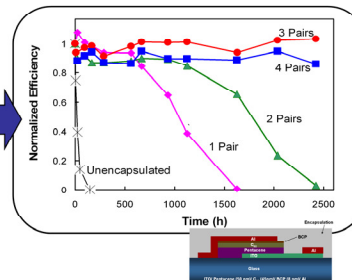
Calcium test geometry:



WVTR determination:



Validation on organic solar cells:



Center on Materials & Devices for Information Technology Research
An NSF Science & Technology Center, DMR-0120967

IMPACT: The development of thin-film barrier coatings for organic electronics is necessary to protect the electronics from water vapor and oxygen found in the environment. In addition, these films will allow for the use of organic electronics in flexible applications. In order to obtain long device lifetimes, it is necessary to develop barrier coatings having effective water permeation rates that are less than 10^{-4} g/m²/day. In addition, the method used to process the encapsulation needs to be compatible with the active device layers in the organic electronics, causing no adverse effects.

DISCUSSION: In this work, we have developed thin-film barrier coatings from PECVD SiN_x (100 nm) and parylene (1 μm) which yielded effective water vapor transmission rates of less than 10^{-5} g/m²/day. It was found that the permeation rate reached a minimum value at 3 bilayer pairs and was improved by thermal annealing of the parylene during the deposition process. The PECVD layers were deposited at 110°C to be compatible with organic electronics. The barrier layers were used to encapsulate pentacene/C₆₀ solar cells on glass substrates. Measurements before and after encapsulation showed no adverse effects on the performance of the solar cells with processing. The encapsulated solar cells were stored in an environmental chamber at 20°C and 50% RH and showed no major degradation in cell performance up to 2,500 h when encapsulated with 3 and 4 bilayers of SiN_x/parylene. Unencapsulated devices showed rapid degradation within the first 60 h while devices encapsulated with 1 bilayer (10^{-2} g/m²/day) and 2 bilayers (10^{-3} g/m²/day) showed major degradation after 600 h and 1200 h, respectively.

KEY PERSONNEL:

Georgia Institute of Technology: Namsu Kim, William Potscavage, Bernard Kippelen, Samuel Graham