Thin-Film Encapsulation of Organic Light-Emitting Devices

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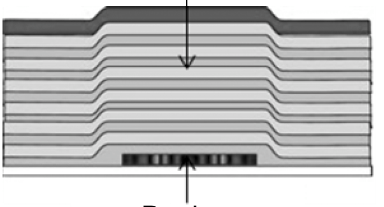

This project seeks to extend the lifetime of organic light-emitting devices (OLEDs) by blocking the transmission of ambient oxygen and moisture into the delicate emissive region of the device. Our approach is to encapsulate the organic device with hybrid thin-film stacks of both organic and inorganic materials. It is projected that, for commercial applications, such an encapsulation scheme will need to reduce the water vapor transmission to 1 x 10^{-6}g/m^2-day and the oxygen transmission to 1 x 10^{-5}cm^3(STP)/m^2-day. We have developed a low-temperature (100ºC) PECVD (ltPECVD) process for both amorphous silicon nitride and amorphous silicon oxide layers which yield optically transparent layers (>85% transmission) with low stress (-1.6 x 10^9 dyne/cm^2, -0.42 x 10^9 dyne/cm^2, for nitride and oxide, respectively) and an index of refraction similar to thin films grown at higher temperatures (1.71, 1.8, for nitride and oxide, respectively). We have begun to incorporate organic thin films into the encapsulation schemes which, while they do not possess the barrier properties of inorganic films, do have the advantage of conformal coverage, which both seals in particulate matter, as well as planarizes the encapsulating stack. One difficulty arising from the low-temperature PECVD processes is the formation of particulate matter on the surface of the OLED. This can be mitigated, somewhat, through an optimization of the PECVD recipes used to deposit films, but could not be eliminated. The best solution, we have found, is to include an organic capping layer of parylene atop the deposited inorganic multi-layers. This project is supported by the Department of the Navy through eMagin Corporation.