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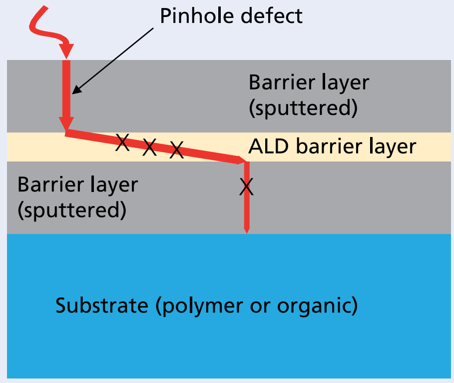

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BARRIER LAYERS FOR THE ENCAPSULATION OF ORGANIC ELECTRONICS

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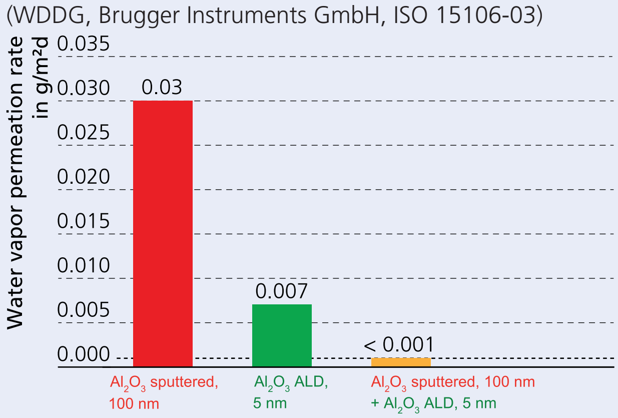
Organic electronics, such as organic solar cells or organic light emitting diodes, rely on functional thin-film layers, which are very sensitive to moisture and oxygen. Desired substrates for the fabrication of these devices are polymers. However, these materials have an insufficiently high water vapor and oxygen permeation. Therefore, an excellent encapsulation and protection of the device against moisture and oxygen is necessary. The encapsulation has to limit the oxygen permeation rate to less than 10^{-3} $cm^3(m \cdot d \cdot bar)^{-1}$ and the water vapor permeation rate to less than 10^{-4} $g(m^2d)^{-1}$. Established encapsulation processes use, for example, layer stacks, in which an organic interlayer with a thickness of some micrometers is embedded in two inorganic barrier layers of a single layer thickness of approx. 100 nm. The inorganic barrier layers are deposited under vacuum by PVD whereas the interlayer is applied by lacquering. The interruption of the vacuum in the process chain hinders the development of overall concepts for encapsulation processes. The encapsulation process developed by IKTS in co-operation with the Fraunhofer FEP combines inorganic barrier layers, applied by magnetron sputtering, with a thin interlayer applied by atomic layer deposition (ALD). The thin ALD interlayer is also deposited in vacuum and covers or respectively seals defects of the sputtered layer (Figure 2) underneath.

Water vapor permeation rates of different barrier layer systems
(WDDG, Brugger Instruments GmbH, ISO 15106-03)



Substrate: PET, 75 µm

A comparison of different barrier layers (left diagram) shows a much better barrier performance of a 5 nm ALD-Al_2O_3 in relation to a sputtered 100 nm Al_2O_3 layer. A combination of these two layers enhances the barrier performance significantly so that the water vapor permeation rate falls below the detection limit of common barrier analyzers. For a better evaluation of the quality of encapsulation properties, a 20 nm ALD-Al_2O_3 layer was embedded in two sputtered Al_2O_3 layers with a single layer thickness of 100 nm on a plastic substrate. In this case, the water vapor permeation rate was determined by the help of an optical calcium test. The obtained value of $6 \cdot 10^{-5}$ $g(m^2d)^{-1}$ is comparable to other encapsulation processes. The use of ALD barrier layers opens new opportunities for continuous manufacturing techniques without vacuum interruption. Furthermore, these analyzes show that even very thin ALD layers are a promising component within overall encapsulation concepts for sensitive organic electronics.

Services offered

- Manufacturing and analysis of barrier layers
- Development of ALD processes
- Sample preparation for product development

1 *ALD lab-scale equipment of the IKTS.*
2 *Structure and mechanism of action of the new barrier layer system.*

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