Go ahead, dunk your cell phone in salt water: Barrier films by atomic layer deposition

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Barrier films, used in everything from food and drug packaging to consumer electronics and solar cells, help prevent your food from spoiling, help to preserve medication, and protect your electronics from damage due to exposure to air or a splash of water. Now a group of researchers in Georgia have developed a new way to produce better films using atomic layer deposition.

These are not the flimsy films of plastic that may seal a package of cookies. High-end barrier films that safeguard your phone's high-tech organic light-emitting diode (OLED) display from every whiff of oxygen or molecule of water vapor require higher performance transparent materials such as metal oxides.

Existing methods for manufacturing these high-performance barriers aren't perfect. Due to the way they're made, they often have small defects, resulting in tiny holes that let in water or oxygen. That's why Samuel Graham and his colleagues at the Georgia Institute of Technology have been exploring how to use atomic layer deposition to produce better barrier films. At the AVS 60th International Symposium and Exhibition, held in Long Beach, Calif. Oct. 27 – Nov. 1, Graham will discuss some of the latest developments in this effort.

Graham and his colleagues have created new barrier films that can protect electronics in very harsh environments – when submerged in salt water for months, for example.

"By creating such barrier films, we are able to extend the lifetime and reliability of electronic devices," Graham said. The new coatings can be used for electronics such as implantable biomedical devices, light-emitting diodes (LED) used in solid-state lighting and displays, solar cells, and organic electrochromic windows, which go from opaque to clear when a voltage is applied. Barrier films will play a large role in the development of many future electronic devices made with organic materials, Graham added.

How Atomic Layer Deposition Works

High-performance barrier films are usually made with techniques such as sputter deposition or plasma-enhanced chemical vapor deposition. In these methods, material is either "sprayed" onto a substrate or grown from a plasma, creating a thin layer that becomes the film. Although efficient and common in industry, these techniques often result in defects, requiring multiple coatings to create good barrier films.

With atomic layer deposition, the researchers have precise control down to the molecular level, allowing them to make thin, even films that have minimal defects. In this process, the researchers surround a substrate with a gas containing a particular metal atom like aluminum. The molecules of the gas attach themselves onto the substrate, forming a single layer of atoms. Next, excess gas is removed from the chamber and another gas is introduced that then oxidizes the metal, creating a metal oxide that's impervious to air or water. The process is repeated to reach the desired thickness, which is only about 10 nanometers. In contrast, films made with more conventional techniques are tens to hundreds of times thicker.

Companies are already developing and selling atomic layer deposition technology, Graham says. But for wide-scale commercial use, more work needs to be done to improve the technology, how fast the materials

are deposited, and the chemical stability and mechanical reliability of the films.

More information: Presentation TF+VT-WeM3, "Improving the Reliability of Electronics Using ALD Barrier Films," is at 8:40 a.m. Pacific Time on Wednesday, Oct. 30, 2013.

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