Barrier films in e-readers: Their form and function

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There is no question that among the most popular and more affordable hand-held electronic devices to hit the market in recent years are e-readers based on e-paper. They go by various names and several brands (Nook, Kindle, Sony, etc) but they all function in the same manner. Add-ons, apps and available upgrades may change with the price and model number, but they all allow us to read text in a form that mimics ink printed on a piece of paper. An electrophoretic process is the driving force behind this technology. Charged submicron particles are suspended in a fluid and encapsulated inside a sub-pixel sized cell.

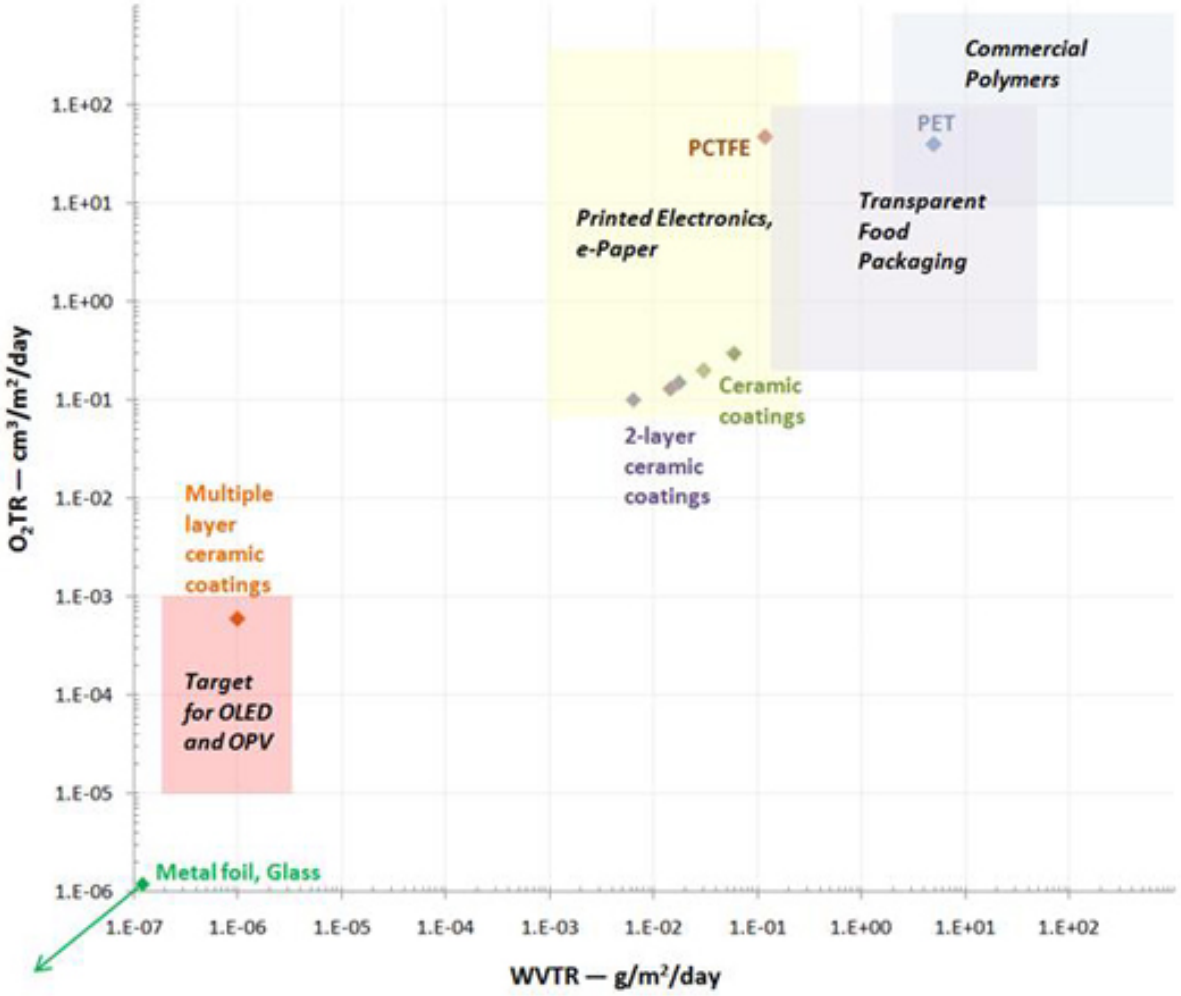
Simply stated, when these

suspended particles are subjected to an electric field, the oppositely charged light and dark particles move in opposite directions. Careful control of each pixel enables the display to mimic the appearance of a high resolution printed page of text. This front plane assembly and many of the components that make up an e-reader (See Figure 1) need protection from the various elements that threaten almost every electronic device — dust and moisture — and, for some components, separation from each other. Barrier films provide excellent protection from moisture and dust and can act to prevent accidental contact between elements. Just as there are many types of e-readers, there are several types of barrier films available and choosing the correct one depends upon the application that it will fulfill.

Barrier selection

Various types of barrier materials are available. In approximate order of effectiveness: polymer, ceramic-coated polymer, multilayered ceramic-coated polymer, metal foil, glass. Glass has essentially perfect barrier properties and most e-readers have glass fronts though this is sometimes for touch screen functionality. A glass layer is heavier than a polymer based layer and not flexible in the finished product. If we extend the paper and e-paper analogy to include flexibility in the final product at some future point, then traditional glass falls off the list. Foil, though flexible, is opaque and thus not suitable for a front barrier at all, though it is used as a rear barrier on many electrophoretic displays. So we will concentrate on polymer and ceramic barriers for the fronts of these devices.

For choosing a suitable barrier material, Figure 2 shows typical ranges of the requirements of various industries and device technologies and their performance. For e-paper applications, oxygen protection is not a primary consideration (as it would be the case of OLED devices, for example). So PCTFE films and single and double ceramic layers coated onto films such as PET are good choices.



The barrier material is not usually selected in isolation from the other requirements of the device and its construction:

- How do we attach the barrier to the e-paper components?
- Do we need a layer to protect the barrier itself?
- Should there be an anti-glare layer on the front?
- Is there a need to incorporate graphics such as icons or switch labels on the front surface?
- Could another functional layer be included such as a transparent conductive layer to form one component of a front touch screen?
- Is UV protection or scratch resistance required?
- What about a temporary protective film?

Barrier films incorporating one or more of these requirements may need additional layers. Nevertheless there is value in minimizing the number of interfaces and the overall thickness to maximize light transmission and clarity of the text or image. This is doubly so because light must pass through these layers on electrophoretic displays twice: Ambient light on the way in and reflected light on the way out. Designing the combined functionality into a single optimized product should be a priority.

The electrophoretic display technology used in e-readers is extremely durable and consumes very little energy. This opens the possibilities for the use of this

technology in other applications especially if it can be made flexible in the final device. Wearable displays and large bendable signage have been made, though they have yet to achieve the explosive growth of e-readers. Better protection from moisture vapor (and oxygen) is being developed, as well as thinner, more durable surface protection. Innovative light management films are being developed.

The demand for electronic displays, whether for hand-held e-readers or some other emergent applications, is growing rapidly. Companies that can meet these challenges have a successful future in front of them.