BARRIER FILMS ON PAPER AND CELLULOSE USING FLUOROCARBON PLASMAS

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The demand for functional packaging materials in the food and pharmaceutical industries is increasing rapidly. Use of flexible barrier packaging will increase 6.1% per year until 2005 across all industries, and 7.7% in the healthcare industry, making it one of the fastest-growing packaging segments [1]. Paper mills use extrusion processes to create a barrier to oxygen, grease and oil, and as protection against environmental change, handling and contamination. Lamination of paper is another method by which barrier properties are achieved. Barrier films should perform the required task without degradation in performance due to changes in environmental conditions such as temperature, relative humidity and light exposure. Plasma polymerization is a common method to modify polymers as well as inorganic and organic materials to add functional groups that can provide new physical or chemical characteristics. Plasma chemistry can be used to modify the surface of paper or cellulose to achieve desired properties (e.g. barrier to moisture and/or grease). Such processes result in the top few monolayers of the material having different (desired) properties than the bulk material, which retains original properties.

We are investigating the use of fluorocarbon plasmas for surface modification of paper and cellulose in packaging applications. The primary fluorocarbon precursors being investigated are pentafluoroethane (C_2F_5H) and octafluorocyclobutane (C_4F_8). One of the key properties of the resulting films is that they are hydrophobic. Although the water uptake of these films is low, the moisture diffusivity through them is high. That is, moisture penetrates the films but is not chemically bonded. This allows the films to freely pass water vapor without permanent chemical incorporation [2]. The absorption of moisture is a bulk phenomenon in which the moisture penetrates into the film. It should be noted, however, that although the films allow water vapor diffusion they are hydrophobic and are not “wetted” when liquid water is brought in contact with these layers. The films are also a good barrier for lipophilic material with a very small amount of lipids going through the films. By appropriately tailoring the plasma conditions such as plasma power, substrate temperature, and pressure, films with high hydrophobicity and excellent grease barrier properties can be obtained. As a result, barrier coatings for packaging and value-added paper products can be synthesized by depositing fluorocarbon layers on the surface of paper and/or cellulose.

References

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