

Poly-paper: a sustainable material for packaging, based on recycled paper and recyclable with paper

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ABSTRACT

Background: Until now, environmental sustainability issues are almost entirely unsolved for packaging materials. With the final aim of finding materials with a single recycling channel, cellulose fiber/poly(vinyl)alcohol composites were investigated.

Methods: After extrusion and injection molding, samples of composite with different cellulose fiber content (30%, 50% and 70% w/w) were tested.

Results: Tensile mechanical tests exhibited an improvement in composite stiffness when the reinforcement content was increased together with a decrease in composite elongation. Solubility tests performed at room temperature and 45°C showed different behavior depending on the water-resistant film applied on the composite (50% cellulose fiber content). In particular, the uncoated composite showed complete solubility after 2 hours, whereas at the same time point, no solubility occurred when a non-water-soluble varnish was used.

Conclusions: The proposed composites, named Poly-paper, appear to warrant further investigation as highly sustainable packaging.

Keywords: Cellulose fiber, Composite, Polyvinyl alcohol, Solubility, Tensile strength

Introduction

Popular packaging materials today involve unsolved environmental sustainability issues. The main reason is that packaging is, in most cases, made of multiple materials (corrugated board, polystyrene foam, polyethylene etc.), which are often disposed of unsorted. Consider the packaging of a TV set or any other home appliance: It includes corrugated board for the outer case, polystyrene foam for inner filling, bubble polyethylene wrap and sundry plastic parts. Each of these materials has a different recycling channel (often a complicated one, as in the case of polystyrene foam). Truly

sustainable packaging should have a single separate collection and recycling channel.

There is no doubt that taking effective steps in view of packaging sustainability will imply using a single material, or rather materials with different properties and functional performance but with the same recycling channel. The above considerations led to our interest in developing a composite material characterized by high environmental sustainability (1).

Paper and board can best satisfy these needs: recycling of corrugated board, newspapers and magazines has been customary for some time now, even before the term *recyclable* became so popular. Sustainability is ensured by the fact that recycling simply requires placing the discarded parts in the paper-and-board bins available close to our homes. However, recycling of our new material alongside the waste paper collected for recycling required using a water-soluble matrix. We chose polyvinyl alcohol (PVA), a polymer-based material produced without diverting fertile lands from agriculture, capable of melting in water and forming nontoxic composites (2, 3). We called this material poly-paper. Poor resistance to water due to the water-soluble matrix is obviously not an issue in this case, because the resistance of Poly-paper to water (which varies according to temperature) is anyway greater than that of corrugated board.

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