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**Sustainpack**

# D5.47 Innovation and sustainable Development in the Fibre Based Packaging Value Chain

Instrument: **IP**

## Report on the energy absorption properties of the MFC based cushions, comparison with existing cushions

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|---|---|---|
| **Dissemination Level** | | |
| **PU** | Public | PU |
| **PP** | Restricted to other programme participants (including the Commission Services) | |
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Cushioning materials in commercial use are dominated by expanded polystyrene (EPS) due to its high mechanical performance. In the context of Sustainpack, we would like to replace EPS

| **Expanded Polystyrene** | **S100** | **Mx200** | **Mx400** |
|---|---|---|---|
| **Modulus (MPa)** | 2.53 | 8.2 | 15.16 |
| **Density (kg/m$^3$)** | 17.8 | 31.36 | 47.40 |
| **Yield strength (kPa)** | 80 | 187 | 310 |

*Data for expanded polystyrene (Sundolitt) with three differentdensities*

by starch-based foams. In the first table (above) data are presented for EPS foams. The highest density foam has a modulus of 15 MPa and a strength of 300 kPa.

The first row in the next table presents data for starch foams based on amylopectin-rich potato starch. The modulus is one third of the one for EPS foam, and the strength is about half the one for EPS. In addition, the density of the starch foam is almost twice as high. There are two major reasons for this. The first is that at steady-state conditions with respect to environmental factors (temperature and relative humidity), starch foams have around 10% of moisture content. This plasticizes the cell wall and lowers modulus and strength. In addition, the starch itself has about 30% higher density than the polystyrene. This is a disadvantage, since the solid content by volume in the foam is the decisive first-order parameter to characterize foam structure. In addition, our work indicates that starch foams have a higher proportion of open cells than EPS foams. As a consequence, the cellular structure is less effective in absorbing energy during shock loads.

The data for MFC reinforced nanocomposite biofoams are very encouraging. At 40% MFC content, modulus is increased by 40% compared with the starch reference. The strength exceeds the strength of EPS by 70% which is a major achievement. As a consequence, the technically important energy absorption is much higher for our nanocomposite biofoam as compared with the EPS reference. We then know that our new mateial concept is highly interesting, although processing problems remain to be solved.

*Data for starch-based materials with 0, 10 and 40 % MFC contents:*

| **MFC (wt%)** | **Young's Modulus (MPa)** | **Yield strength (kPa)** | **Density , ρ$^*$ (kg/m$^3$)** | **Water content (%)** |
|---|---|---|---|---|
| **0** | 4.85 | 169 | 102.9 | 11.0 |
| **10** | 5.01 | 312 | 108.9 | 10.3 |
| **40** | 7.01 | 508 | 95.1 | 8.4 |

Starch based foam with varying MFC contents. The samples have been conditioned in 50% RH and 22 °C for 48 h.