

Flax fibers as polymer composite reinforcement

M. Scandola, E. Zini - Dep. of Chemistry 'G. Ciamician', University of Bologna, Italy

In applications as polymer reinforcing agents, natural fibers offer several advantages (their renewable origin, world-wide availability, low production energy requirements, reduced equipment wear, biodegradability and thermal recyclability by combustion) over man-made fibers such as glass, carbon and aramid. Particularly attracting is the low density of vegetable fibers that leads to high specific mechanical properties. However, vegetable fibers do not usually perform satisfactorily as polymer reinforcement, owing to their high surface polarity.

In a composite the efficiency of fiber reinforcement depends chiefly on the capability to transfer the applied stress from the continuous phase (matrix) to the fibers. This is not achieved with vegetable fibers owing to poor adhesion between the hydrophilic surface of the fiber and the essentially hydrophobic polymers which are commonly used as the matrix. The potentiality of natural fibers as composite reinforcing agents is impaired.

In this work mild chemical treatments have been applied to flax fibers commonly used in the textile industry, with the aim of changing surface tension and polarity through modification of the surface chemistry, thus improving adhesion at the fiber-matrix interface. The performed fiber surface changes were monitored by FT-IR, TOF-SIMS and ESCA. WAXS measurements showed that the applied chemical treatments did not alter fiber crystal structure. The fibers maintained good mechanical properties after chemical modification and preserved their biodegradability. Composites containing such chemically modified fibers and polyesters as matrix polymers were tested. Compared with the reinforcing effect of unmodified flax, fibers with selected surface modifications were found yield higher strength composites.

References

- M. Scandola, S. Sandri, M. Baiardo, G. Frisoni, European Patent "Surface chemical modification of natural fibers", **2000**, Appl. N°: 00830474 (US Patent Filed: July 5, 2001), publication number EP 1170415A1.
- G. Frisoni, M. Baiardo, M. Scandola, D. Lednickà, M. Cnockaert, J. Mergaert, J. Swings "Natural cellulose fibers: heterogeneous acetylation kinetics and biodegradation behavior", *Biomacromolecules*, **2001**, 2, 476-482.
- M. Baiardo, G. Frisoni, A. Licciardello, M. Scandola "Surface chemical modification of natural cellulose fibers", *J. Appl. Polym. Sci.*, **2002**, 83,38-45.
- E. Zini, M. Scandola, P. Gatenholm "Flax fibers for composite reinforcement: controlling fiber surface by chemical modification", *Biomacromolecules*, **2003**, in press.