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Study of the Adaptation of Bio Cellulose Nano-Fibers for the Restoration of Historical Paper, Parchment and Textiles

Abstract

Bacterial cellulose (BC) obtained in the bacterial biosynthesis by *Gluconoacetobacter xylinus* is considered one of the most interesting materials tested and is used in different areas of human activity. The success of its applications in the medical and food industries has launched a study of this material on a large scale. Many characteristics and unique properties of bacterial cellulose are already used in the paper industry.

Studies and practical adaptation of bacterial cellulose in our research are the one of the first tests in the area of conservation. The exception is the addition of bacterial cellulose sample during the manufacture of handmade paper, which, as noted, had a positive impact on the properties of the paper and led to the conclusion that paper with the participation of bacterial cellulose could be used for archival and preservation purposes. Research undertaken in this study is the first extensive experience seeking to use the unique properties of this material, such as high strength and elasticity, content of pure cellulose with a high degree of polymerization and the ability of this material for modification. Studies¹ were made jointly with the Institute of Biochemistry, Technical University of Łódź, Poland.

Microscopic analysis (SEM, Environmental Scanning Electron Microscope, Atomic Force Microscope) showed significant differences in the structural construction of paper and bacterial cellulose (BC). BC is a multi-layered product, as opposed to a paper. It consists of a large number of layers of very fine meshes of micro fibrils, whose thickness is usually in the tens of nanometers (usually less than 100 nm).

1 Biotechnology (2007–2009)

Preliminary investigation of bacterial cellulose indicated the need to modify the native membrane by drying to form sheets, and further grinding in the presence of water. Suspensions of bacterial cellulose, known in our work as hydrogels, were modified with the addition of fillers, dyes, methyl cellulose and fibres of paper, fabric, leather and parchment. The addition of methyl cellulose to the solution had a positive influence on the properties of suspension and sheet forming.

Research on the adhesive properties of hydrogels demonstrated that they could also be used as a binder. Suspensions of bacterial cellulose fibres used for bonding paper and fabric samples reinforced them at the same time.

Cellulose suspension has a very good adhesion to paper, fabric, leather and parchment, so that they do not require the use of other binders.

The inclusion of bacterial cellulose in studies and in practical application in restoration practice proved to be a valuable idea. The results obtained were very interesting and we are planning to continue this project with the aim of reinforcing book and archival paper of the 19th and 20th century, photographs and leather items damaged by red rot.