

Cellulose repulpable adhesive bonding of wet and dry cellulosic substrates

Elisa S. Ferreira^{1,2} (PG), Juliana da S. Bernardes¹ (PQ) e Fernando Galembeck^{1,2} (PQ)*

¹ National Nanotechnology Laboratory at the National Center for Energy and Materials Research, Campinas SP, Brazil 13083-970.

²Institute of Chemistry, University of Campinas, P.O. Box 6154, Campinas SP, Brazil, 13083-970.

Keywords: Adhesive, Repulpable, Cellulose, Wet substrates

Introduction

Solutions of cellulose in alkaline solvents [1] have been recently used to prepare films, fibers and membranes [2,3]. Cellulose is rather stable in aqueous solutions of NaOH and other alkalis that do not release toxic gases and are relatively inexpensive. Despite all the advantages, adhesive properties of these aqueous solutions have not been previously determined. Wet cellulose substrates are difficult to bond, wherein the adhesives known are complex like polyvinylamine onto carboxylated poly(N-isopropylacrylamide) microgels, specially designed for this application [4]. Besides, repulpable adhesives are desirable to paper and cellulose industry, allowing pulp re-processability and paper recycling, solving a well-known industrial problem related to “stickies” deposition on paper machines [5].

Results and Discussion

Recent results from this laboratory show that cellulose-based adhesives can be prepared as solution or paste and they successfully bond wet or dry paper, paperboard, cellophane, fabric and other cellulosic substrates. Bonded paper can be reconverted to pulp that is undistinguishable from the original pulp, without “stickies”.

A single lap adhesive joint prepared using wet paper and cellulose aqueous adhesive was imaged by microtomography (Figure 1). Higher electronic density regions (blue points) along the paper matrix indicate that the plasticized cellulose chains fill the gaps between fibers, evidencing the deposition of dissolved cellulose on cellulose fibers and thus promoting a good adhesion.

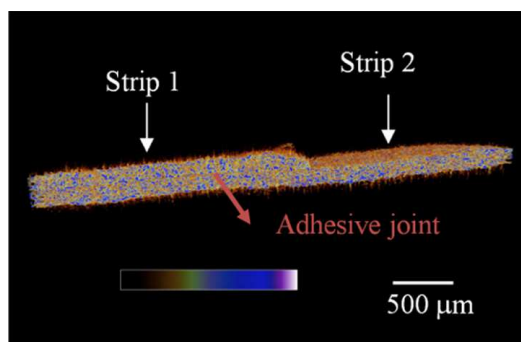


Figure 1. Cut surface from X-ray microtomography reconstruction of joined paper strips.

Uniaxial tensile tests of filter paper strips joined by cellulose aqueous adhesive composed by 5% microcrystalline cellulose and 7% NaOH (Figure 2) show that failures never occurs in the joint but in unaltered paper areas. The maximum strength is ca. 12 MPa, when the substrate rips, the same as in the control experiment.

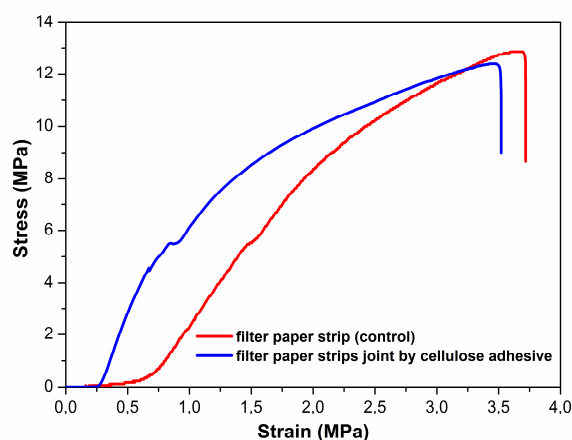


Figure 2. Stress-strain diagram for filter paper strip joined by water-based cellulose adhesive.

Conclusions

Adhesives for wet and dry cellulosic substrates can be prepared from cellulose dissolution in alkaline aqueous medium.

Paper substrates joint by cellulose aqueous adhesive are repulpable, facilitating paper re-processability.

Aqueous cellulose adhesive can be used as reinforcement agent for cellulosic substrates, since paper substrates joined by the adhesive are mechanically more resistant than paper, due to the fill of paper porous by cellulose chains.

Aknowledgments

CNPq and INCT-Inomat.

¹ Kamide, K.; Okajima, K., *U. S. Patent* 4,634,470 1987.

² Qi, H.; Chang, C and Zhang, L., *Green Chem.* 2009, 11, 177.

³ He, M.; Xu, M. and Zhang, L., *ACS Appl. Mater. Interfaces* 2013, 5, 585.

⁴ Quan, W.; Pelton, R. *Langmuir* 2012, 28, 5450.

⁵ Venditti, R. A.; Lucas, B. E.; Jameel, H., *Prog. Pap. Recycl.* 2007, 16,18.