

An interdisciplinary view on the strength of a fiber – fiber bond in paper

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ABSTRACT

The strength of a piece of paper is determined to a large extent by the strength of the fiber – fiber bond. While paper strength is a very important parameter, especially for Kraft paper producers, surprisingly little is known about the fiber – fiber bond.

In this paper an overview about the bonding mechanisms that have been suggested will be given. As can be seen in figure 1 five different bonding mechanisms have been postulated [1] before.

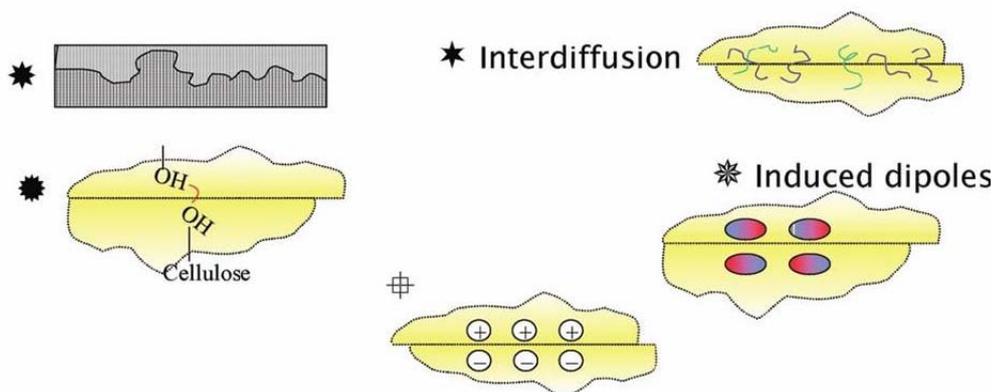


Figure 1: Five different bonding mechanisms for two paper fibers (after [1]).

The first one (top left in figure 1) is mechanical interlocking, which can be seen as a mixture of friction and an effect comparable to a Velcro fastening. The second mechanism (top right in figure 1) is the interdiffusion of cellulose molecules between the two bonded fibers. The third mechanism (middle left in figure 1) is hydrogen bonding between the cellulose molecules of the two fibers. The fourth mechanism (middle right in figure 1) is basically Van der Waals bonding between the fibers

and the fifth bonding mechanism (bottom in figure 1) is the coulomb interaction between charged species in the two fibers. These bonding mechanisms will be discussed with respect to their possible influence seen from a surface science perspective.

To gain more insight into the bond strength of a single fiber – fiber bond between two paper fibers results of the determination of the bonded area from two independent analysis methods (polarization microscopy [2, 3] and microtomy [4]) will be discussed. This is the first prerequisite to be able to measure specific bond strength. The second prerequisite is a method to actually measure the bond strength between two paper fibers. Here an atomic force microscopy based approach will be discussed.

A model system that can be used to investigate the influence of hemicelluloses on the bond between two cellulose surfaces will be presented briefly. Here the surface chemistry and the tribology of the surface will be investigated.

Finally it will be shown how the results of these approaches could be used to get a more detailed understanding of how large the influence of the five different bonding models on the overall binding strength is. Such an improved model of the bond between individual paper fibers can then be used to enhance our understanding of paper strength.

References

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