ACID BI-SULPHITE PULPING EFFECTS ON HARDWOODS AND A SOFTWOOD REVEALED BY ATOMIC FORCE MICROSCOPY

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Wood fibres are the raw material used in the production of dissolving pulp for the manufacture of cellulose derivatives such as viscose and cellulose acetate. At the microscopic level, the wood cell wall is organised in layers with different thicknesses and proportions of lignin and hemicelluloses[1]. Within the cell wall layers, cellulose exists as a system of fibrils with diameters of 3-4 nm aggregated into larger structural units[2]. Lignin and hemicellulose bound to cellulose fibrils are removed during pulping, resulting in closer association between fibrils. However, excessive aggregation of fibrils is believed to reduce dissolving pulp reactivity by restricting accessibility of chemicals to cellulose chains. It is therefore critical to control aggregation of cellulose fibril aggregates (CFA) during processing in order to preserve the reactivity of dissolving pulp.

Previous Atomic force microscopy (AFM) studies on a species of *Eucalyptus* showed that there is an increase in the CFA dimensions during pulping and bleaching[3]. This increase in CFA was exacerbated by subsequent drying of dissolving pulp fibres[4]. It has been proposed that the incorporation of varying amounts of hemicelluloses and residual degraded cellulose could account for the increase in CFA observed after drying[4]. In this study, the AFM was used to investigate the ultrastructural appearance of CFA in transverse sections of cell walls in wood and unbleached pulp fibres from *Pinus patula* and four different *Eucalyptus* species. The content of hemicellulose, cellulose and lignin present in the wood fibres was determined and related to the changes in CFA observed.

Wood samples were infiltrated with acetone/resin before embedding in epoxy resin. Pulped fibres were freeze dried to avoid drying artefacts and later infiltrated and embedded in epoxy resin. Imaging of ≥5 fibres per treatment was performed on 1µm thick transverse sections and imaged using a MDT Solver P47H AFM in tapping mode. Image-Pro® Plus 6.0 with watershed segmentation was used to determine average CFA dimensions.

The CFA dimensions of fibres in wood from *Pinus patula* and four different *Eucalyptus* species ranged from 27±1 to 39±2 nm. The CFA dimensions of the corresponding unbleached pulp fibres ranged from 30±1 to 41±2 nm. CFA dimensions varied more among *Eucalyptus* species than between this genus and *P. patula*. A decrease in total lignin content by *c.* 85% after pulping corresponded to an increase in CFA dimensions of *c.* 9% for two of the *Eucalyptus* species (Figures 1 – 4). However, the role played by hemicelluloses and degraded cellulose during fibril aggregation was not clear. The influence of chemical composition and anatomical properties on the observed increase in CFA will be discussed.

References

1. Brändström, J. (2001) Int. Assoc. Wood Anat. J. 22 (4), 333.
2. Frey-Wyssling, A. (1968) Wood Sci. Technol. 2, 73.
3. Chunilall, V., Wesley-Smith, J. and Bush, T. (2006) Proc. Microsc. Soc. South Afr. 36, 45.
4. Chunilall, V., Wesley-Smith, J. and Bush, T. (2008) Proc. Microsc. Soc. South Afr. 38, 46.

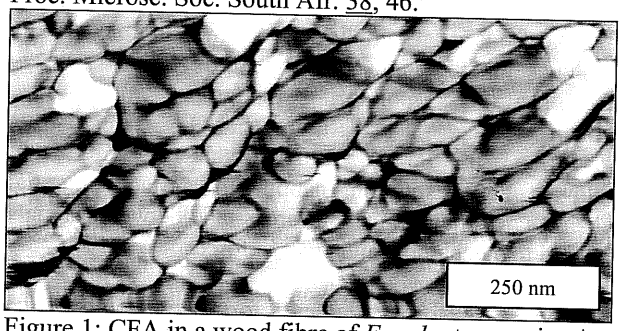

Figure 1: CFA in a wood fibre of *Eucalyptus* species A

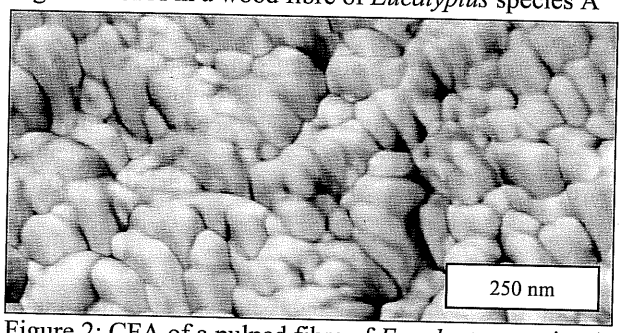

Figure 2: CFA of a pulped fibre of *Eucalyptus* species A

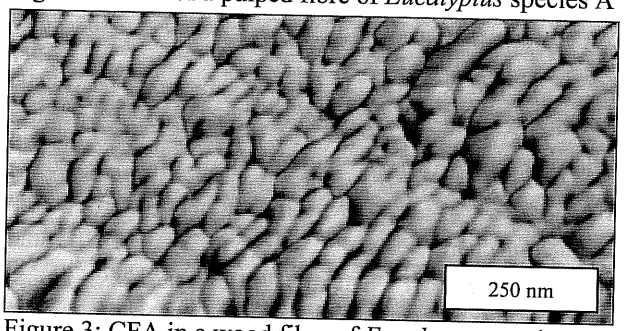

Figure 3: CFA in a wood fibre of *Eucalyptus* species B

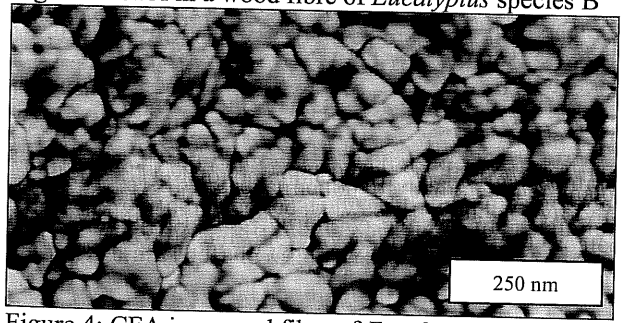

Figure 4: CFA in a wood fibre of *Eucalyptus* species B

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