CELLULOSE FIBRIL AGGREGATION STUDIES OF *Eucalyptus* DISSOLVING PULPS USING ATOMIC FORCE MICROSCOPY

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Dissolving pulp is the end-product of acid-bisulphite pulping and bleaching processes, during which almost all non-cellulosic wood components are removed to produce dissolving pulp with final α-cellulose purity (α) of up to 96%. Dissolving pulp is subsequently modified chemically to produce derivatives such as micro-crystalline cellulose, viscose and acetate. Therefore, reactivity is an important aspect of dissolving pulp.

Structurally, cellulose is made up of anhydroglucose monomers that polymerise into glucan chains. Several glucan chains form individual fibrils (cellulose molecules) and these, in turn, form fibril aggregates. Atomic force microscopy (AFM) has revealed that there is a marked increase in the lateral fibril aggregate dimension (LFAD) during pulping and bleaching[1]. Furthermore, Krassig[4] observed that when pulp fibres are dried rapidly, hornification (irreversible and close association of fibrils) occurs. Excessive aggregation of fibrils is believed to reduce pulp reactivity by restricting accessibility of chemicals to cellulose fibrils. It is therefore critical to control aggregation of cellulose fibril aggregates (CFA) during processing and drying in order to preserve the reactivity of the pulp.

Previous studies using a clone of *Eucalyptus* revealed different degrees of aggregation in dissolving pulps processed to either 92 or 96% α-cellulose purity[1]. It has been proposed that the different amounts of hemicelluloses persisting after bleaching to these end-product purities could account for the observed difference in LFAD[1]. This study describes the ultrastructural changes in CFA measured in dissolving pulp of *Eucalyptus* dried using contrasting methods. The 92 and 96% α-cellulose pulps were freeze-dried to avoid conformational changes, or oven-dried at 105°C degrees for 18 hours. Fibres were embedded in epoxy resin, microtomed transversely into 1 µm-thick sections and imaged in tapping mode using Nanoscope and Solver P47H AFMs. Image analysis using watershed segmentation was used to measure average LFAD.

AFM images of fully bleached 92 and 96% grades after freeze- or oven-drying, are shown in Figures 1-4, respectively. The CFA dimensions for the freeze-dried 92 and 96 α-cellulose pulps were 24.0 ± 0.8 nm and 30.1 ± 0.9 nm, respectively. The aggregate dimensions of the oven-dried 92 and 96 α-cellulose pulps increased to 35.9 ± 1.3 nm and 47.9 ± 1.3 nm, respectively. Results confirm the notion that CFA increases with both, increasing bleaching and during drying. These trends are supported by previous studies using solid state NMR, where it was shown that oven drying irreversibly increases the LFAD of dissolving pulps [2, 3].

References
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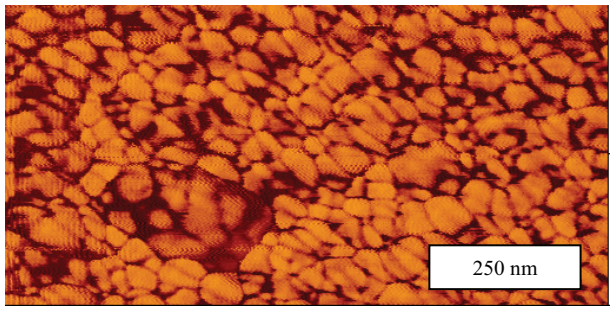

Figure 1. Fully bleached 92 α (freeze dried)

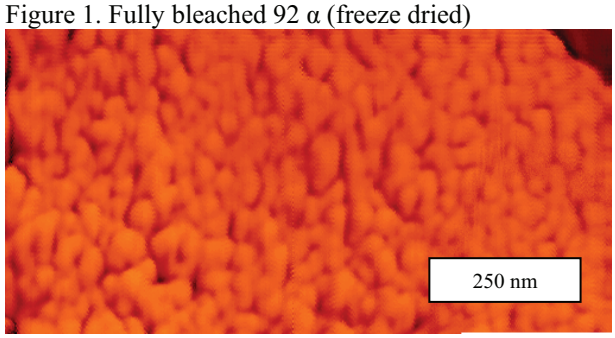

Figure 2. Fully bleached 96 α (freeze dried)

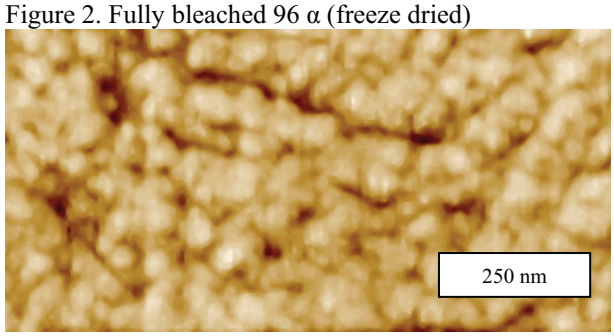

Figure 3. Fully bleached 92α (oven dried)

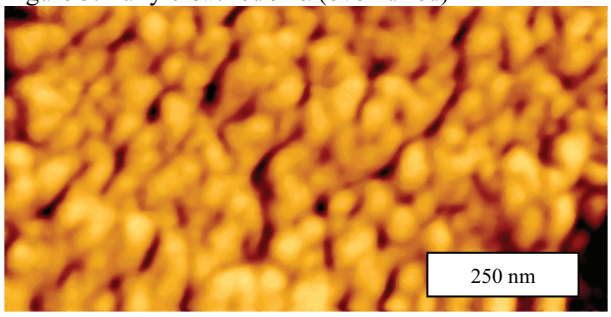

Figure 4. Fully bleached 96 α (oven dried)

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