Impact of Mutations on the Architecture of Arabidopsis Stems

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We applied scanning x-ray microdiffraction from thin sections of Arabidopsis stems in order to map the structural organization of cellulose fibrils in the stems and to explore changes in this structure induced by alterations in the genes involved in lignin biosynthesis. Scanning x-ray microdiffraction (SXMD) was carried out using a 5 micron beam that moved across the sections in 5 micron steps and complete diffraction patterns were collected at each raster point. Approximately 16,000 diffraction pattern were analyzed to determine cellulose fibril orientation and order within the tissues making up the stems. SXMD enables us to determine the positional dependence of cellulose architecture not accessible by conventional x-ray techniques. Working with very small scattering volumes, the separation of scattering into oriented and disoriented components represents a more accurate measurement of local cellulose crystallinity than would be possible using a ~ 100 micron beam. As expected, the oriented component exhibits most of the signature features of scattering from cellulose, including the (1 1 0)/(-1 1 0), (2 0 0) and (0 0 4) reflections. Orientation of cellulose fibrils was estimated and microfibril angles determined from the split of (2 0 0) reflections. Axial coherence length of (0 0 4) reflections provided insight into the variation of order of cellulose fibrils. The structural information extracted from SXMD reveals the changes in cellulose architecture triggered by alternations in lignin composition. These studies indicate that SXMD has the potential for studies of the variations in tissue architecture on the micron scale.