Dynamic bending properties of natural fibers measured by electrostatic vibration system

**(Graduate School of Agriculture,
Laboratory of Biomass Morphogenesis and Information, RISH, Kyoto University)**

Toshiyuki Iburi

A system to measure dynamic properties of a single plant fiber is developed. The fiber is placed in an oscillating electrostatic field and the resonance frequency, damping of vibration both in vacuum and in air are successfully measured. With this new instrument, physical properties of traditional native fibers, namely, *Boehmeria nivea, Boehmeria sylvestris, Laportea macrostachya* was investigated.

Experiments

Natural fiber samples were collected from field in the late June, 2008. The phloem fibers (bast fibers) was peeled off from the plants and purified by pectinase treatment. They were washed thoroughly and then freeze dried. The experimental setup developed in the laboratory is shown in Figure 1[1]. Conditions for measurement are as follows: frequency region 20Hz～6000Hz、distance between electrodes 0.2～0.5mm, oscillating voltage 100V+-70V. Young's modulus of a single fiber is calculated from the equation $E=4f^2\pi^2(l/1.875)^4\rho A/I$, where f: resonance frequency l: length of a fiber ρ: density A: cross sectional area I: geometrical moment of inertia.

Results

Averaged Young's moduli of fibers from *B. nivea, B. sylvestris,* and *L. macrostachya* were calculated to be 83.8GPa, 66.1GPa, and 90.9GPa, respectively. Interestingly, the modulus from *L. macrostachya* was statistically smaller than those of the other two species. The technique developed in this study may be applied for identifying the origin of natural fiber, which is often required in archeological science.

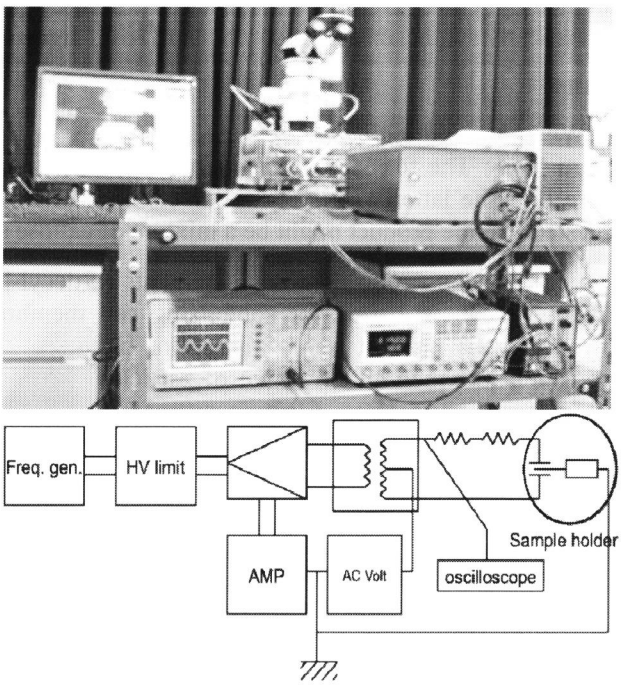

Figure 1 A general experimental setup.

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References

[1] Meredith, R, Hsu, B-S: "Dynamic bending properties of fibers: Effect of temperature on nylon 66, terylene, orlon, and viscose rayon" J. Polym. Sci. 61, pp. 271-291, 1962