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APPLICATION OF TIME-OF-FLIGHT NEAR INFRARED SPECTROSCOPY TO WOOD

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In this study, the newly constructed optical measurement system, which was mainly composed of a parametric tunable laser and a near infrared photoelectric multiplier, was introduced to clarify the optical characteristics of wood as discontinuous body with anisotropic cellular structure from the viewpoint of the time-of-flight near infrared spectroscopy (TOF-NIRS). The combined effects of the cellular structure of wood sample, the wavelength of the laser beam λ, and the detection position of transmitted light on the time resolved profiles were investigated in detail.

The variation of the attenuance of peak maxima At, the time delay of peak maxima Δt and the variation of full width at half maximum Δw were strongly dependent on the feature of cellular structure of a sample and the wavelength of the laser beam. The substantial optical path length became about 30 to 35 times as long as sample thickness except the absorption band of water. $\Delta t \times \Delta w$ representing the light scattering condition increased exponentially with the sample thickness or the distance between the irradiation point and the end of sample. Around the λ=900-950 nm, there may be considerable light scattering in the lumen of tracheid, which is multiple specular reflection and easy to propagate along the length of wood fiber. Such tendency was remarkable for soft wood with the aggregate of thin layers of cell walls. When we apply TOF-NIRS to the cellular structural materials like wood, it is very important to give attention to the difference in the light scattering within cell wall and the multiple specular-like reflections between cell walls. We tried to express the characteristics of the time resolved profile on the basis of the optical parameters for light propagation determined by the previous studies, which were absorption coefficient K and scattering coefficient S from Kubelka-Munk theory and n from nth power cosine model of radiant intensity. The wavelength dependency of the product of K/S and n, which expressed the light-absorbing and -scattering condition and the degree of anisotropy, respectively, was similar to that of the time delay of peak maxima Δt. The variation of the time resolved profile is governed by the combination of these parameters. So, we can easily find the set of parameters for light propagation synthetically from Δt.