Characterization of Silk Produced in Japan During the 12th Century

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Nuclear magnetic resonance (NMR) has been widely accepted as an excellent characterization method in physics, chemistry, and biology as well as medical diagnosis. In this paper we show the applicability of NMR to archaeological polymer science. Mummies of three gentlemen are well preserved in Chusonji Temple in Northeastern Japan. They are Kiyohira Fujiwara, Motohira Fujiwara, and Hidehira Fujiwara, all belonging to the Fujiwara clans who governed Northeastern Japan in the 12th century. All of them were wound in silk. ^{13}C solid-state high resolution NMR spectra were observed for these silks with the aid of the CP (cross polarization)/MAS (magic angle spinning) technique. For the convenience of comparison, SEM (scanning electron microscope) patterns were observed. From the former the fraction of Silk II (antiparallel β-sheet) structure was calculated, while from the latter the cross section and the circularity coefficient [1] of filament were determined. The fraction was defined by the ratio of intensity of the higher field $C=O$ peak to that of the total $C=O$ one. [The lower field one was assigned to Silk 1 (random coil) structure.] The coefficient is the ratio of cross section of the filament to the cross section of the circle with the largest diameter of the corresponding filament. There was good correlation in these three quantities. These quantities are well-correlated with the climate (temperature) of the years of death. Climate was estimated from the annual rings of a living tree [2].

CONCLUSION

Higher temperature produces a silk filament with a larger fraction of Silk II structure, a larger cross section, and a larger circularity coefficient. In order to verify the above conclusion, we are going to determine the three quantities for silks produced in the first half of this century for which climate data are well known.

REFERENCES

[1]   J. Nunome, *Kinu Sen-i Ibutsu no Kenkyu*, 1967.
[2]   T. Mitsutani, Unpublished Data.