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Application News

No. N134

Micro Focus X-Ray CT System

Example of Observation of CNF-Containing Foamed Plastic by inspeXio™ SMX™-100 CT

Introduction

Among molded resin products, those with a porous structure produced by adding a foaming agent and hot forming are called foamed plastic. Because foamed plastic contains a large number of voids in its internal structure, it is lightweight and has excellent heat insulation and shock absorbing properties. On the other hand, its porous structure also reduces its strength, as its density is smaller than that of non-foamed plastic.

As a method for securing light weight and strength while imparting a heat insulation property, fibers are added to foamed plastics as a reinforcing material. Although various types of fibers are used, including glass fibers and carbon fibers, research on the use of cellulose nanofibers (hereinafter, CNF) as the reinforcing material is progressing. CNF, a high performance new material of biological origin, is produced by refining cellulose, which is the main component of plant cell walls, to the nano level. Weighing only 1/5 as much as steel, CNF has high specific strength no less than five times that of ferrous materials. While high production cost is still a challenge for practical application, CNF has attracted attention as a new fiber material following carbon fiber.

This article introduces an example of observation of the internal structure of foamed plastic containing CNF as a reinforcing material by using an inspeXio SMX-100CT micro focus X-ray CT system (Fig. 1).

T. Hashimoto

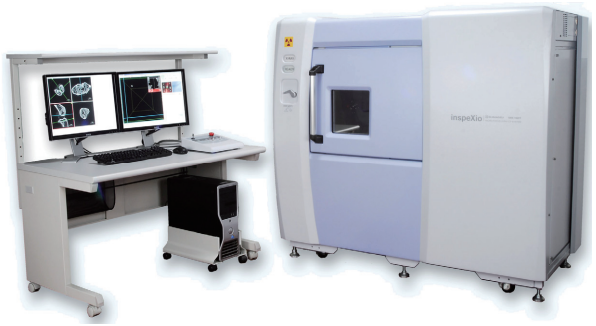

Fig. 1 inspeXio™ SMX™-100CT Micro Focus X-ray CT System

Observation of Foamed Plastic Containing CNF

In this experiment, specimens*1 of high density polyethylene (hereinafter, HDPE) (width: 18 mm, thickness: 4 mm, height: 40 mm) prepared for use in a tensile test, as shown in Fig. 2, were observed. Four types of specimens with and without CNF and with different foamed states were prepared, as shown in Table 1.

*1: Specimens were provided by the Kyoto Municipal Institute of Industrial Technology and Culture.

Fig. 2 Appearance of HDPE Specimen

Table 1 Types of Samples Observed

①	CNF0% non-foamed
②	CNF0% foamed
③	CNF5% non-foamed
④	CNF5% foamed

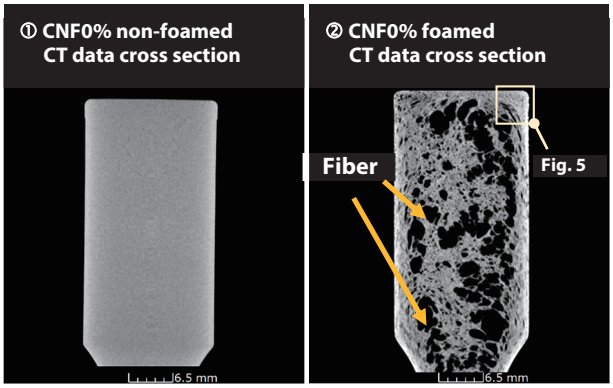

Fig. 3 Cross-Sectional Images of CNF 0% HDPE ① Non-Foamed Material, ② Foamed Material (Field of view: 40 mm)

Fig. 3 shows cross-sectional HDPE images of the specimens without CNF addition. Fig. 3 ① is an image of the non-foamed material, and ② shows the foamed material. Higher density parts are shown in white and lower density parts in black. The non-foamed material shown in Fig. 3 ① has a homogeneous internal structure. In contrast, the foamed material in Fig. 3 ② is not homogeneous and its internal structure contains numerous voids of various sizes.

The same specimen of foamed material was scanned with the field of view narrowed from 40 mm to 6 mm, as shown in Fig. 4. The result is shown in Fig. 5. The existence of finer voids than those could be seen in Fig. 3 could be confirmed by narrowing the field of view.

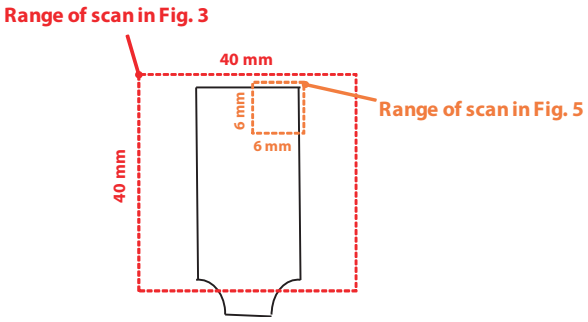

Fig. 4 Scanning Field of View of Specimen

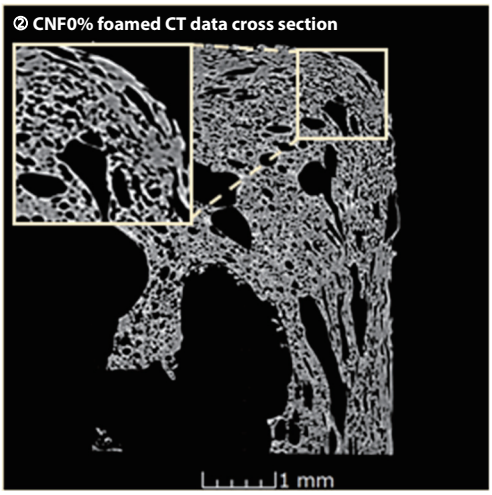

Fig. 5 Cross-Sectional Image of CNF 0% HDPE Foamed Material (Field of view: 6 mm)

Fig. 6 shows cross-sectional HDPE images of the non-foamed and foamed materials with 5% added CNF when scanned at the same magnification as in Fig. 3. In the non-foamed material in Fig. 6 ③, as in Fig. 3 ①, a homogeneous structure was observed. In the foamed material with 5% CNF addition in Fig. 6 ④, the points where voids can be observed were the same as the results for the foamed material without CNF addition in Fig. 3 ②, but overall, the size of the voids was small, and there were few voids in the range of several mm near the specimen surface.

Fig. 7 shows the cross-sectional image when a small sample of the non-foamed material with 5% CNF addition was cut out and scanned with the field of view changed to 6 mm as in Fig. 5. In this specimen, the presence of linear inclusions, which were not seen in the cross-sectional images of the specimens without CNF, could be confirmed in the resin. Similar inclusions were also observed in the foamed material with 5% CNF addition, as shown in Fig. 8. It is thought that the inclusions observed here are cellulose that was not defibrated to the nano level, and in this specimen, masses of fibers having a width of at least over 10 μm were included in the specimen containing 5% CNF.

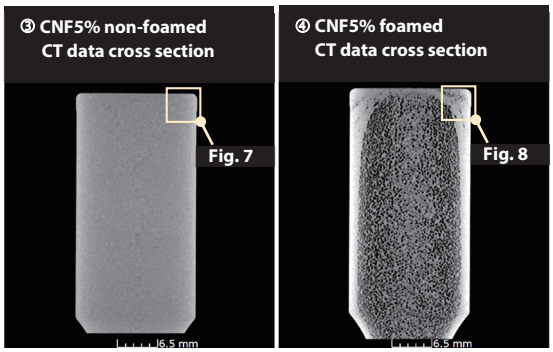

Fig. 6 Cross-Sectional Images of CNF 5% HDPE ③ Non-Foamed Material, ④ Foamed Material (Field of view: 40 mm)

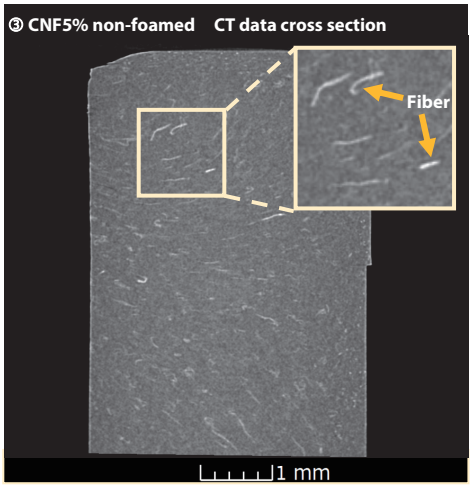

Fig. 7 Cross-Sectional Image of CNF 5% HDPE Non-Foamed Material (Field of view: 6 mm)

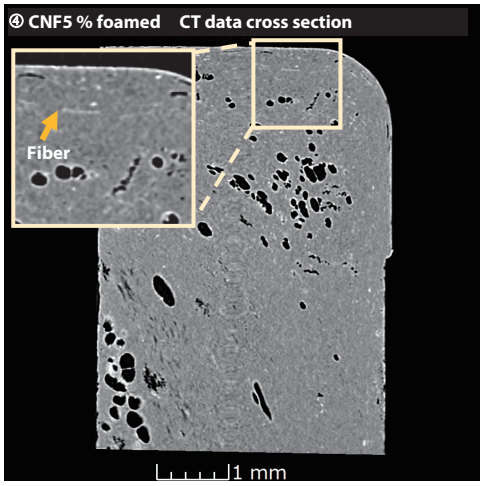

Fig. 8 Cross-Sectional Image of CNF 5% HDPE Foamed Material (Field of view: 6 mm)

Conclusion

It is possible to observe the differences in the internal structure of plastics with and without fibers and with different foamed states by X-ray CT scanning, as demonstrated in the observations reported here.

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