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Application News

Microfocus X-ray CT System inspeXio™ SMX™-225CT FPD HR Plus

# Observation of PET Bottle Using Microfocus X-ray CT System

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## User Benefits

- Tightness and internal impurities of a PET bottle cap, invisible from outside, can be observed in a non-destructive and simple manner.
- The gap between a cap and a bottle is visualized through three-dimensional (3-D) representations and the gap size is determined.

## ■ Introduction

The basic technology of PET bottles was established by DuPont in 1967, and these bottles have been widely used as containers for soft drinks, seasonings and liquors. In 1974, carbonated drinks in PET bottles were introduced in the U.S. PET bottles have various advantages including being light and chip-proof, can be opened and closed repeatedly, molded into various shapes, and are highly recyclable and environmentally friendly.

Even after being opened, PET bottles are often carried with liquid in them. Therefore, to prevent leaking, it is important to make sure that the PET bottles are manufactured as designed and that the caps properly tighten.

A microfocus X-ray CT system is an essential tool to observe the tightness of PET bottle caps. This X-ray CT system makes it possible to visualize an internal 3-D structure without destroying objects.

Herein, an example of an observation of a PET bottle cap using a Shimadzu inspeXio SMX-225 CT FPD HR Plus micro focus X-ray CT system (Fig. 1) is described.

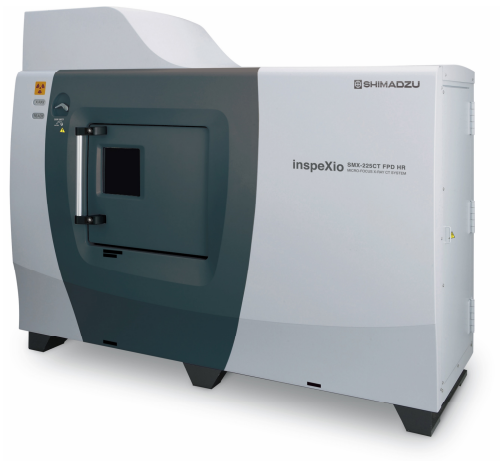


Fig. 1 Microfocus X-ray CT system
inspeXio™ SMX™-225CT FPD HR Plus

## ■ Observation of PET Bottle

Fig. 2 shows an external image of the PET bottle being observed. The bottle has been opened once, and is empty.

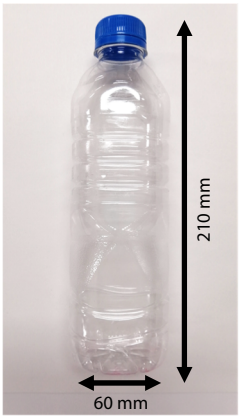


Fig. 2 External appearance of PET bottle

Fig. 3 shows a 3-D representation and a cross-sectional image of the PET bottle. In the 3-D representation and cross-sectional image, higher density areas appear whiter as the density increases, whereas lower density areas appear black.

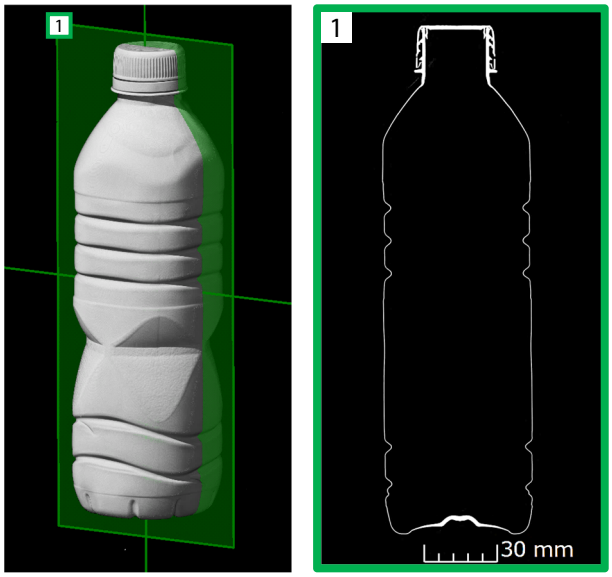


Fig. 3 3-D representation and cross-sectional image of PET bottle

Fig. 4 shows an enlarged 3-D representation and cross-sectional images of the PET bottle cap. Images 1 and 2 show the cross and longitudinal sections of the cap. Image 3 shows an enlarged scan of the section where the mouth meets the cap, wherein the top and side surface of the mouth are in close contact with the cap to prevent leaking. In Image 4, an enlarged scan focused on the impurities inside the cap, and the length of the impurity is measured. The impurity appears comparatively whiter, which possibly indicates that it is denser than the cap.

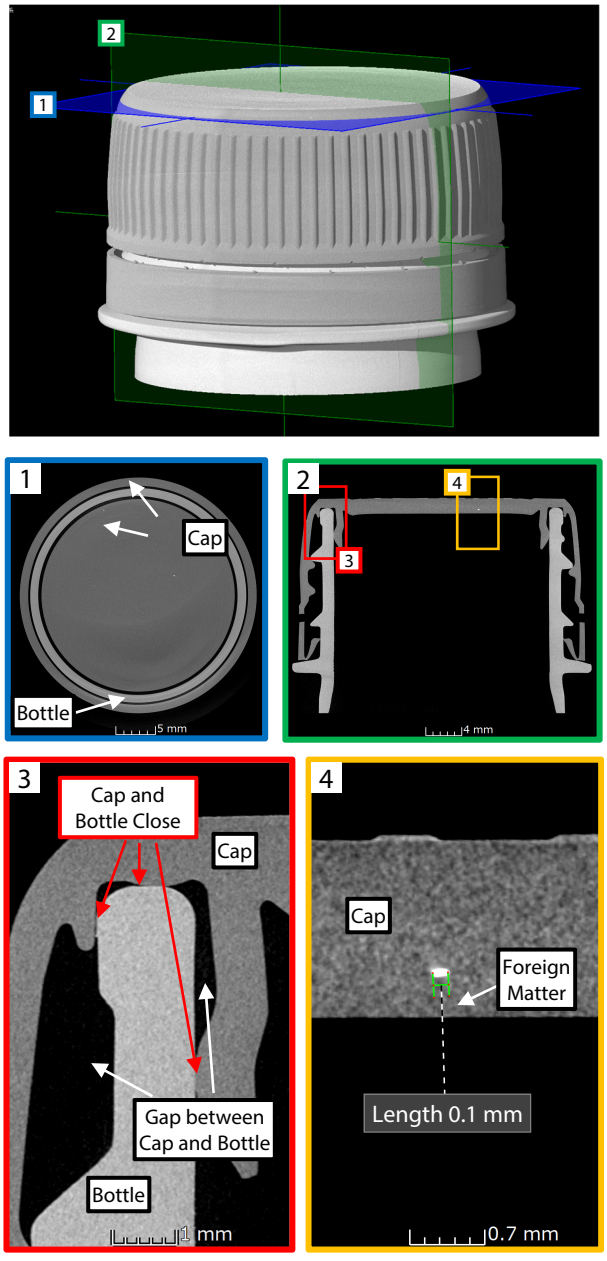


Fig. 4 3-D representation and cross-sectional images of PET bottle cap

＊1 Ratio of gap size when the total number of voxels is 100%
＊2 A unit of 3-D space just as a pixel of two-dimensional space



Fig. 5 shows cross-sectional images, wherein the gaps in Fig. 4 are measured and colored according to the size. The wider gaps are shown in warm colors, and the narrower gaps are shown in cold colors. In Fig. 5, the measured length of the largest gap is 1.6 mm. Fig. 6 shows a 3-D representation of the gap analysis. In the 3-D representation, the bottle and the cap are translucent aiding the easy observation of the gap thickness. The higher part of the cap shows colder colors, which indicates the gaps are smaller. Fig. 7 shows a histogram of the gap analysis. The horizontal axis represents the gap size, and the vertical axis represents the ratio (*1) of the number of voxels (*2). In the area analyzed, the maximum gap length is 1.6 mm.

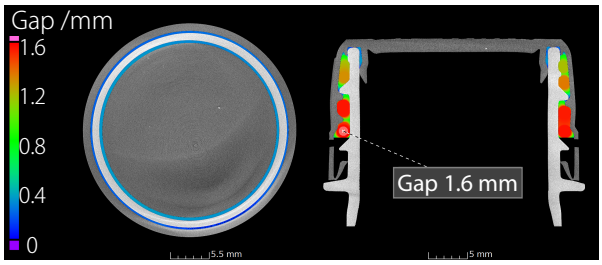


Fig. 5 Example of gap analysis: Cross-sectional image of PET bottle cap

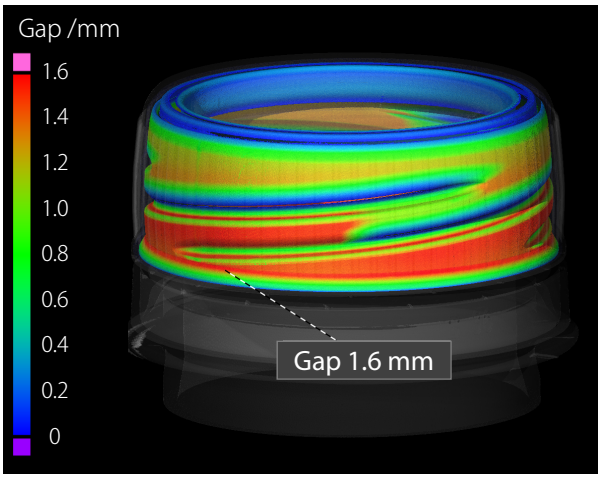


Fig. 6 Example of gap analysis: 3-D representation image of PET bottle cap

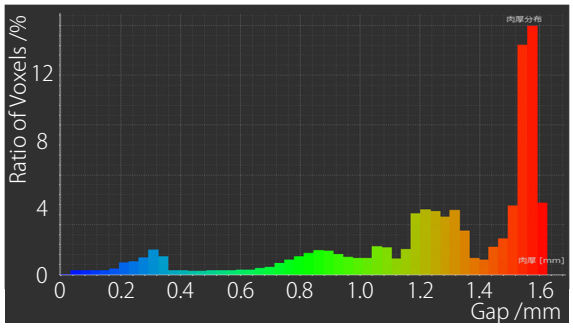


Fig. 7 Example of gap analysis: Histogram of PET bottle cap

## ■ Conclusion

As demonstrated in this experiment, the microfocus X-ray CT system can visualize the inside of the cap non-destructively and confirm that there is an absence of liquid leakage, impurities or defects, thereby contributing to product quality control.

01-00012-EN First Edition: Mar. 2021

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