Development of rod-shaped grinding media for cryogenic mill

[**Background**] In pyrolysis-GC/MS, reducing sample particle size as a pretreatment step enhances measurement reproducibility. Recently, there has been increasing demand for efficient grinding devices, especially for microplastic analysis. Typical commercial grinding devices use spherical grinding media. This note reports the excellent grinding ability of a rod-shaped grinding medium made of super-hard stainless steel and demonstrates its superiority over spherical media by comparing the fine powder yields obtained when grinding wood (toothpicks) and superfiber samples.

[**Experimental**] (1) Toothpick: Two toothpicks (approx. 0.2 g) were cut into 5 mm pieces and ground at room temperature using a rapid cryogenic mill (IQ MILL-2070, Frontier Labs) with the spherical and rod-shaped grinding media. The resulting powder was sieved to < 80 mesh (< 173 µm), and the yield of the fine powder was measured. (2) Superfiber: A 4 m length (approx. 0.25 g) of fully aromatic polyester superfiber (Vectran (F) #30; 0.16 mm diameter) was cut into 5 mm pieces. The sample and grinding medium were placed in a sample container, then immersed in liquid nitrogen for 10 min, and ground in one cycle using the cryogenic mill. This process was repeated twice, followed by sieving as shown in Fig. 1, to obtain the yield of fine powder. The fine powder yields were compared between WC spherical and rod-shaped grinding media.

[**Result**] Figures. 2 and 3 show the photos and yields of the ground toothpick powders. The yield of fine powders < 80 mesh was 1.7 times higher when using the rod-shaped grinding medium compared to the spherical medium. Similarly, Figs. 4 and 5 show the grinding results for the superfiber Vectran, where the yield of 40-80 mesh powder was 1.9 times higher with the rod-shaped medium. However, the yield of powders larger than 40 mesh was significantly lower - only about 1/19th - compared to the spherical medium. These results suggest that rod-shaped grinding medium is more effective for producing fine powders than spherical medium.

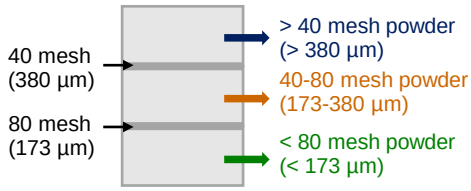

Fig. 1 Schematic of classification by sieving

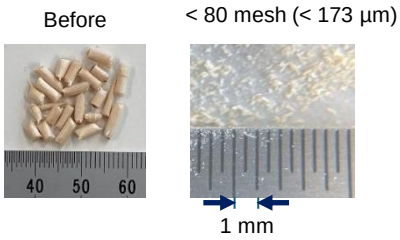

Fig. 2 Before and after grinding toothpicks

Grinding temp.: room temp., Milling speed: 3,000 rpm, Grinding time: 30 s, No. cycles: 1 cycle, Grinding media: rod-shaped SS grinding media

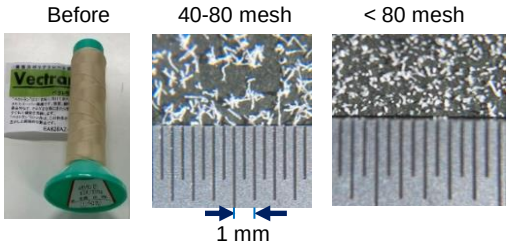

Fig. 4 Before and after grinding super fiber

Grinding temp.: cryogenic, Cooling time: 10 min (every 1 cycle), Milling speed: 3000 rpm, Grinding time: 30 s, No. cycles: 2 cycles, Grinding media: Rod-shaped SS grinding media

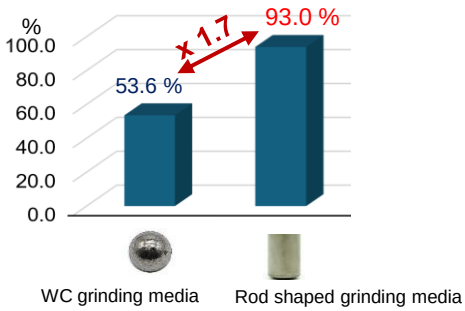

Fig. 3 Yields of < 80 mesh fine powders obtained by grinding and sieving of toothpicks (averaged value of *n*=2)

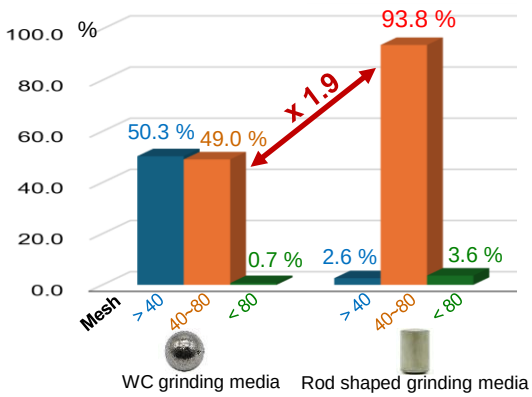

Fig. 5 Yields of fine powders obtained by grinding and classification of super fiber (averaged value of *n*=2)

1) Technical note PYA1-164E

Keywords :	Cryogenic grinding, Room temperature grinding, Micronization, pulverization, ball, rod
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Applications :	General polymer analysis
Related technical notes :	PYT-039E

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