Basic operation of Cryogenic Mill IQ MILL-2070

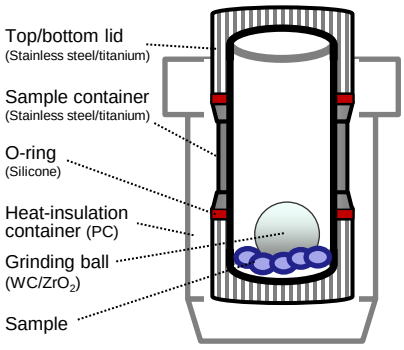
[**Background**] In pyrolysis (Py)-GC/MS measurements, the reproducibility improves as the sample's particle size decreases due to increased thermal conductivity. One of the methods to reduce the particle size of a sample is the cryogenic grinding. This method uses a refrigerant such as liquid nitrogen (N_2) to freeze the sample before grinding. This can be used for resins and fibers samples that are difficult to grind at room temperature. It can also be used for oily and viscoelastic samples; however, current commercial grinding apparatus has problems in terms of grinding time, liquid N_2 consumption, and noise during grinding. This note describes a new rapid cryogenic grinder which has been developed to address the problems of conventional commercial products together with its basic operation.

[**Operation and features**] The new grinding apparatus IQ MILL-2070 is capable of both room-temperature grinding and cryogenic grinding. Fig.1 shows the operating procedures of this apparatus. (A) Put a sample and a grinding ball in the sample container, tighten the screw-lid, and store it in a heat-insulation container. (B) Immerse the heat-insulation container set into liquid N_2 in a cooling container to pre-cool it for 5 to 10 min. Note that step (B) is not required for room temperature grinding. (C) Remove the insulation container set from the cooling container and set it on the grinding apparatus. (D) Enter the grinding speed, grinding time, number of cycles, and pause time between cycles through the front panel of the main unit, and press the START button. (E) During grinding, the sample is rapidly ground by the rapid reciprocating torsional motion of the grinding ball. Table 1 summarizes the grinding conditions. The core features are 1) Low noise (55 dB*)[1)], 2) Low consumption of liquid N_2 (no liquid N_2 required when grinding at room temperature)*, and 3) Short grinding time (10-60 s).

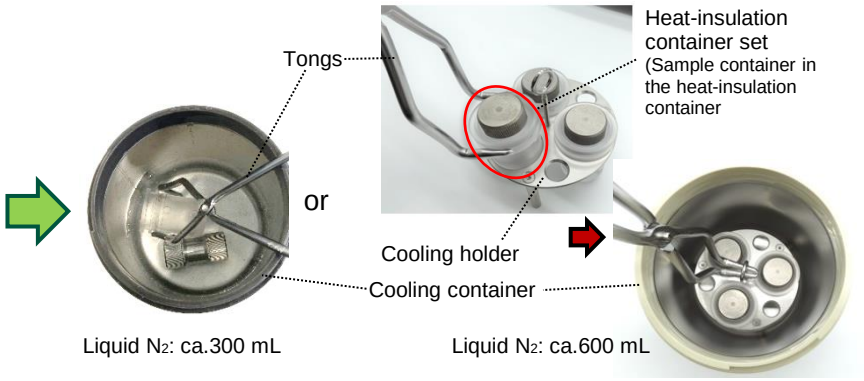
Table 1 Basic grinding conditions

Sample cooling time	5-10 min
Grinding time	10-60 s
Grinding speed	50-3,000 rpm
Max no. of samples ground at a time	3
Max sample amount	1.0 g / container
Liq. N_2 consumption (cryogenic grounding)	300-600 mL
Noise	55 dB*
Weight	12 kg

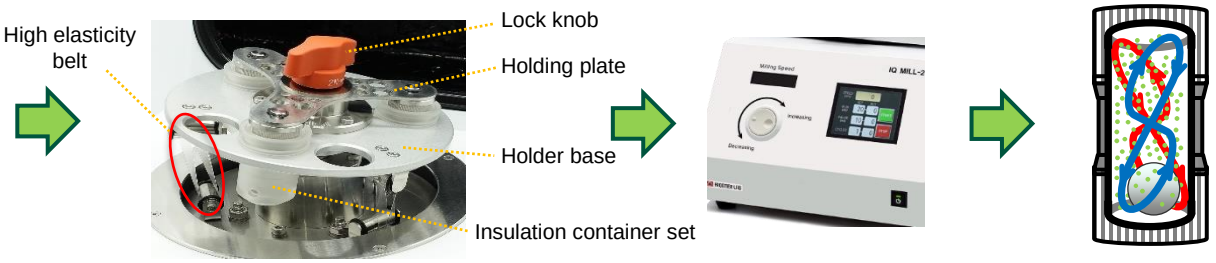
* 1 g of PS pellets ground with 12 mmΦ Zr grinding ball at 3,000 rpm



(A) Cross section of sample container and heat-insulation container



(B) Pre-cooling (left: one sample container, right: three sample containers)
*This procedure is not needed when grinding at room temperature.



(C) Grinding area inside the device

(D) Setting grinding parameters

(E) Movement of a grinding ball

Fig. 1 IQ MILL-2070 operating procedure

* IQ MILL-2070 product brochure

Keywords : Cryogenic grinding, Room temperature grinding, Pulverization

Products used : Cryogenic Mill IQ MILL-2070

Applications : General polymer analysis

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