

Application data sheet #08

Freeze crushing machine **FREEZE CRUSHER μ T-48**

Example of various freeze-crushing samples including non-living materials

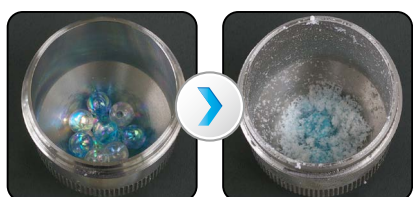


Freeze-crushing of plastic samples using a stainless-steel strong crushing jar

Results and discussion

In this experiment, we selected samples and attempted to crush polystyrene, polypropylene, and polycarbonate from well-known plastics. The symbol \odot indicates the sample was crushed into powder. The symbol \circ shows that the sample was crushed, but the particles were a little rough. The symbol Δ means uncrushed matters remained, while the symbol \times indicates most of the sample was uncrushed.

Polystyrene (1): Δ



Shape and amount of sample:
 ϕ 6 mm ball, 1 g
 Shaking speed: 1,000 r/min.
 Crushing time: 300 sec.

Polystyrene (2): Δ



Shape and amount of sample:
 ϕ 6 mm ball, 0.4 g
 Shaking speed: 1,000 r/min.
 Crushing time: 300 sec.

Polystyrene (3): \odot



Shape and amount of sample:
 10 mm square chip, 0.5 g
 Shaking speed: 1,000 r/min.
 Crushing time: 180 sec.

Polypropylene (1): \circ



Shape and amount of sample:
 10 mm square chip, 0.5 g
 Shaking speed: 1,000 r/min.
 Crushing time: 150 sec.

Polypropylene (2): $\circ?$



Shape and amount of sample:
 10 mm square chip, 0.5 g
 Shaking speed: 1,100 r/min.
 Crushing time: 300 sec.

Polycarbonate : \times



Shape and amount of sample:
 10 mm square chip, 0.5 g
 Shaking speed: 1,000 r/min.
 Crushing time: 300 sec.

Polystyrene could be fully crushed into powder (3). However, for a six-millimeter-diameter ball-shaped sample, we changed the amount and crushing time, and then tried to crush it several times, but a large fragment remained at a certain rate (1) and (2). It appears that during shaking for crushing, the ball-shaped sample moved behind the upper side of the crusher so it was not fully crushed, leaving some fragments. From this result, it was suggested that a chip (or tablet) would be the most suitable shape for a sample.

Polypropylene could not be crushed into powder, but it was able to be crushed into fine fragments (1). Toward improvements (though this exceeded the limit of shaking speed with a stainless steel strong crushing jar), we performed shake-crushing at 1,100 r/min. for five minutes and the sample became fine but was entangled with fragments like cotton (2). Once in this state, as a disadvantage of using Polypropylene, unless a suspension is applied to the solvent, collection becomes difficult.

It turned out that polycarbonate is difficult to crush. We increased the shaking speed to 1,100 r/min. or reduced the amount. In this experiment, only a little powder resulted, while the shape of the chips persisted.

About the properties of individual plastics (quotation)¹⁾

Polystyrene (PS): Possesses high stiffness, is nontoxic, and has dimensional stability. It excels in resistance to a solution, but for a solvent, it is limited resistance. It has a transparency close to glass and is often used for disposal experiment apparatuses. It is comparatively susceptible against shock.

Polypropylene (PP): Has a structure similar to polyethylene. It is semi-transparent and can be used with an autoclave, but at room temperature it is susceptible to strong oxidizing agents. Among polyolefins, it has the strongest resistance against stress cracking, but becomes fragile at low temperatures.

Polycarbonate (PC): Is highly transparent and very strong. It is nontoxic and can be used with an autoclave. It is the strongest among thermoplastics resins, but its resistance against an organic solvent is not that high. When exposed to a base or strong acid at a high temperature, it causes a chemical reaction or hydrolytic degradation. Its high strength and dimensional stability are most suitable for a container with high-speed centrifugal separation.

The procedure for freeze-crushing when a stainless steel strong crushing jar is used

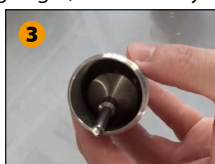
A plier wrench is useful for putting in or taking out a stainless steel strong crushing jar ("Strong Crushing Jar") into liquid nitrogen (see photo (4)). One should wear leather gloves as opposed to cotton work gloves when touching a frozen Strong Crushing Jar or the container holder in the body that has become cooled by contacting it. Please note it is necessary to ventilate the room sufficiently when using liquid nitrogen. Vaporized liquid nitrogen becomes a huge volume of nitrogen gas, and one may become hypoxic without even noticing. Please take extra caution here.



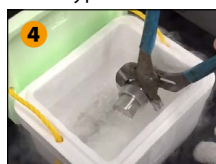
1 Pour liquid nitrogen into a Styrofoam container^{*1}



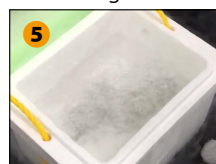
2 Put measured samples^{*2} into a Strong Crushing Jar



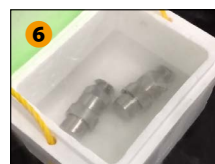
3 Put in a special crusher that is shaped like a spinning top and firmly tighten the lid



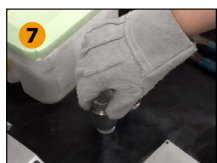
4 Use a plier wrench, etc. to fully submerge the Strong Crushing Jar into the liquid nitrogen



5 Put the lid on the Styrofoam container and wait until the liquid nitrogen boils up



6 When boiling subsides^{*3}, use the plier wrench, etc. to take out the Strong Crushing Jar



7 Put the Strong Crushing Jar onto a stable place and hold it while wearing a leather glove



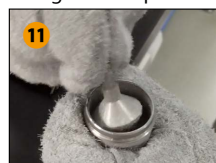
8 Set the frozen Strong Crushing Jar in the equipment and cover it with a mounting rack cover^{*4}



9 Fix the mounting rack cover with the black knob^{*5}



10 Shake container at the prescribed speed and time



11 When shaking is completed, open the Strong Crushing Jar and check inside^{*6}



12 If the content is crushed to satisfaction, the procedure is complete^{*7}

*1: To minimize the amount of liquid nitrogen used, it is best to use a Styrofoam container of the smallest size so that the necessary number of Strong Crushing Jars can be fully submerged without difficulty.

*2: The amount that can be processed with the Strong Crushing Jar is one or two grams per jar, but in the case of plastic samples, it is preferable to limit the amount to 0.5 g. (Polystyrene that can be easily frozen or crushed, up to 1 g.)

*3: To sufficiently freeze the sample in a Strong Crushing Jar, wait at least two minutes after full boiling starts.

*4: In consideration of balance and the reliability of fixing, at least two [frozen] Strong Crushing Jars should be mounted. Metals shrink when frozen, so unless both jars are frozen, the jar heights will change, which will prevent a firm fixing.

*5: Since December 2017, a new rack without thumbscrews for fixing containers has been employed. For older racks that require thumbscrews for fixing containers, firmly tighten the black knob at the center, but do not overtighten the thumbscrews at the four corners to ensure that the pressing plate is not badly bent.

*6: As crushed samples may become attached to the crusher, gently tap the internal wall of the container (it is often not completely fallen off.)

*7: If crushing is insufficient, put the crusher into the container and shake again.

Now on sale

Freeze crushing machine
FREEZE CRUSHER
 μ T-48

(The container holder
is optional)



①48-tube holder for μ T-48 TH-0248T

For off-the-shelf 2-mL round bottom micro tubes. Eppendorf Safe-Lock Tube, 2.0 mL (Catalog No. 003000120094) recommended. Includes 100 pieces of metal crushers. Processing amount: 0.1 to 0.2 g (0.1 to 0.2 mL)/tube.

②3-tube holder for μ T-48 TH-0203T (four-piece set)

For off-the-shelf 2-mL round bottom micro tubes (recommendation and processing amount same as (1)). Includes 24 metal crushers and a rack to be mounted on the chassis.

It crushes samples frozen by liquid nitrogen. In addition to crushing biological tissues, organs, and hard tissues such as a bone, it can crush some plastics and rubbers. It supports off-the-shelf 2 mL tubes and optional robust stainless-steel crushing jars.

③Stainless steel strong crushing jar TH-SPT (four-piece set) →

A container for stronger crushing. Up to four pieces can be mounted on a chassis. A four piece/set. Includes 24 pieces of crushers for exclusive use and a rack to be mounted on chassis. Processing amount is normally 1 to 2 g (1 to 2 mL)/piece; 0.5 to 1 g (0.5 to 1 mL)/piece for plastics and other hard materials. Up to 1,000 r/min. when used.



Stainless steel crushing jar and crusher



When set on a rack

Written and edited by:

TAITEC Corporation
2693-1 Nishikata, Koshigaya-shi, Saitama-ken, 343-0822, Japan
TEL: +81-48-986-3228
FAX: +81-48-988-8363
E-mail: overseas@taitec.org Website: <https://e-taitec.com/>

Quotations/Reference

1) Plastic technical material, AGC TECHNO GLASS Co., Ltd.

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For inquiries about the Freeze Crusher μ T-48 and the contents of this leaflet, please contact us as provided on the left.