

Types of Fractures Experienced by Plastics and Methods of Improvement

R&D Center

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Fracturing of plastic molded parts occurs when the molded part can't endure the impact load beyond the plastic material's limit strength. As such, fractures occur in various ways influenced by applied plastic materials, design of molded parts, operating conditions, external circumstances, and so on.

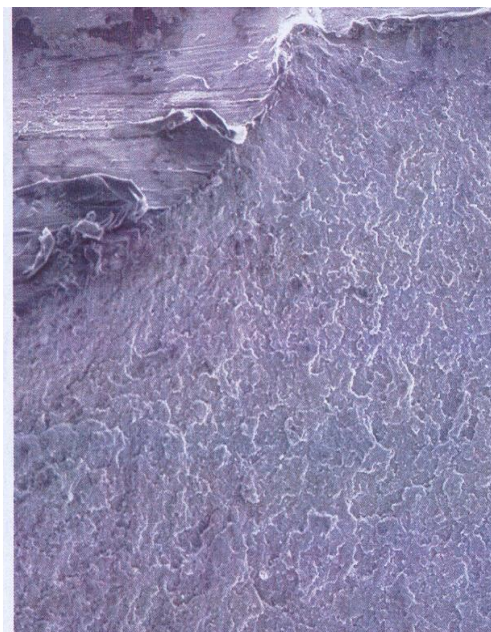
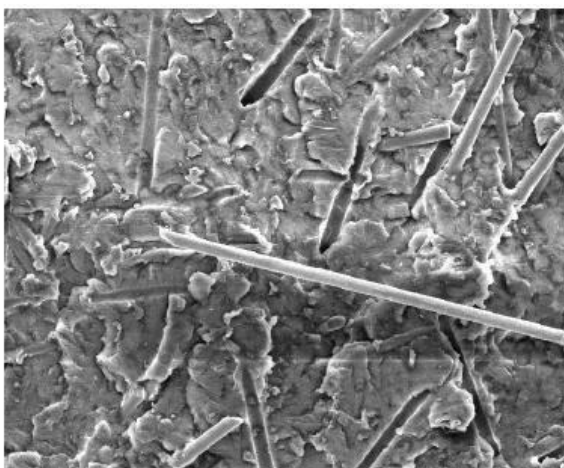
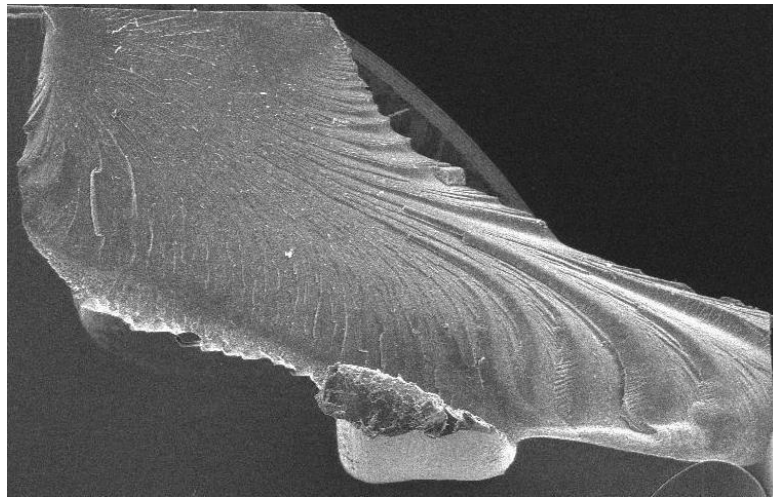
The special surface observing equipment, SEM(Scanning Electron Microscope) is most often used in observing the fracture appearance minutely for understanding specific causes of fracturing.

This document will review the variety of fracture types and their causes, consequently finding methods of improvement.

1. Fracture causes by type

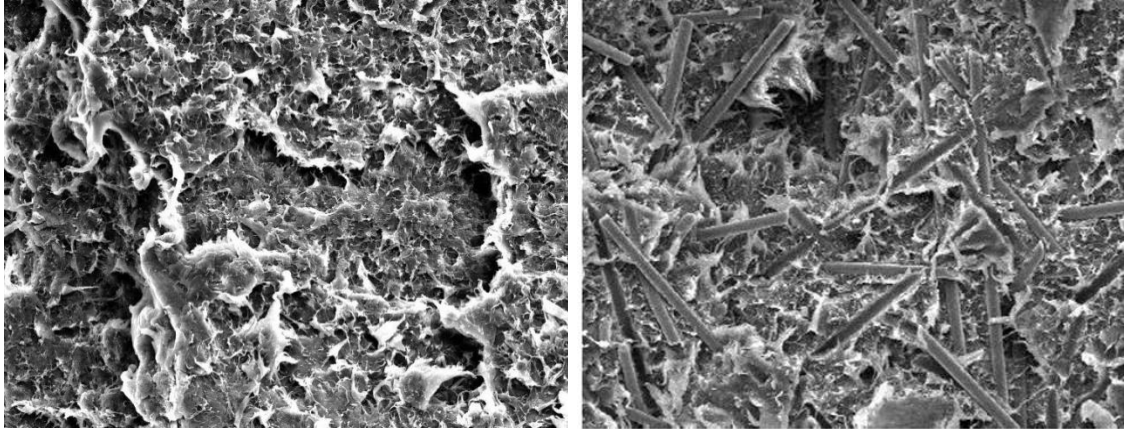
(1) Fracturing due to sudden shock

- 1) Fracture shape : The surface of fracture appearance is clean without any dirty stains.
- 2) Cause : Fracturing occurs due to sudden shock which plastics can't endure.



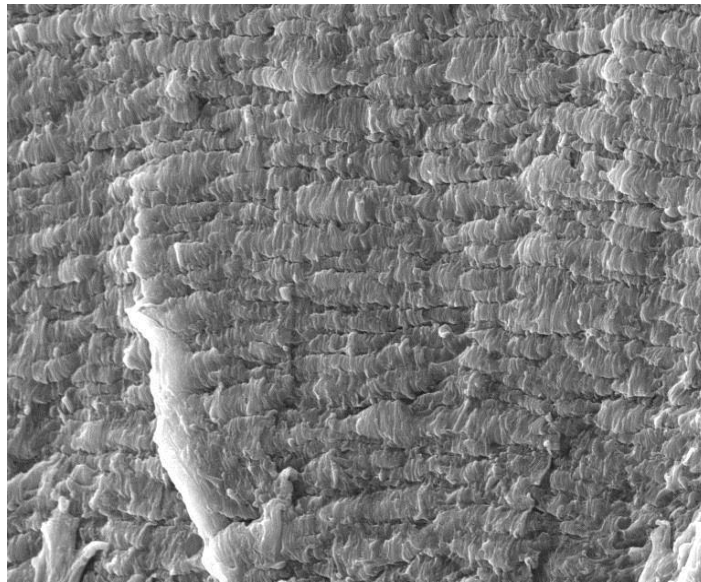
(2) Fracturing due to creep

- 1) Fracture shape : Observed tears of resin at the surface of fracture appearance.
- 2) Cause : The fracture occurs after enduring consistent external force.



(3) Fracturing due to fatigue

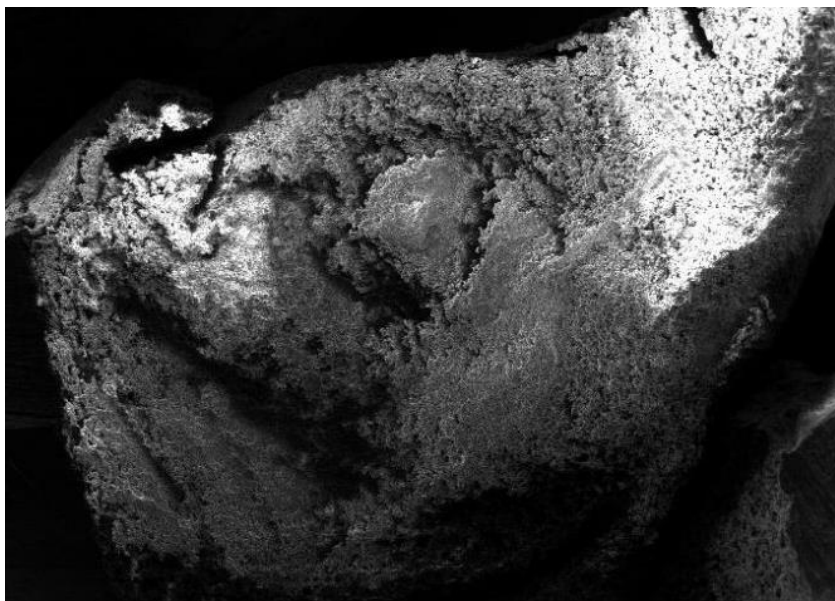
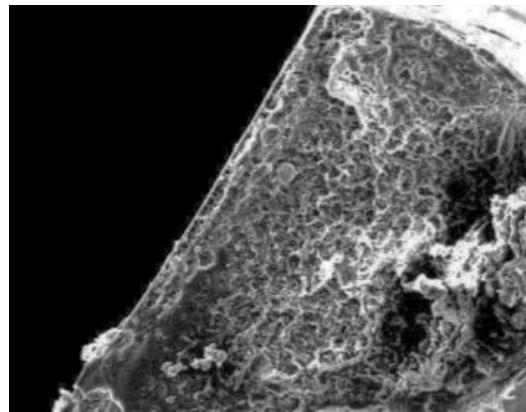
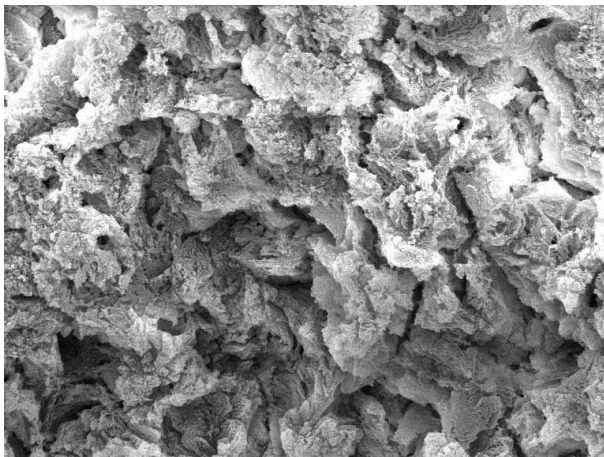
- 1) Fracture shape : The transverse lines shaped like tree rings are observed at the surface of fracture appearance.
- 2) Cause : The part's fracture occurs due to the stress by periodic vibration and operation (Feature : it takes for a long time to incur the fracture.)



(4) Fracturing due to chemical degradation

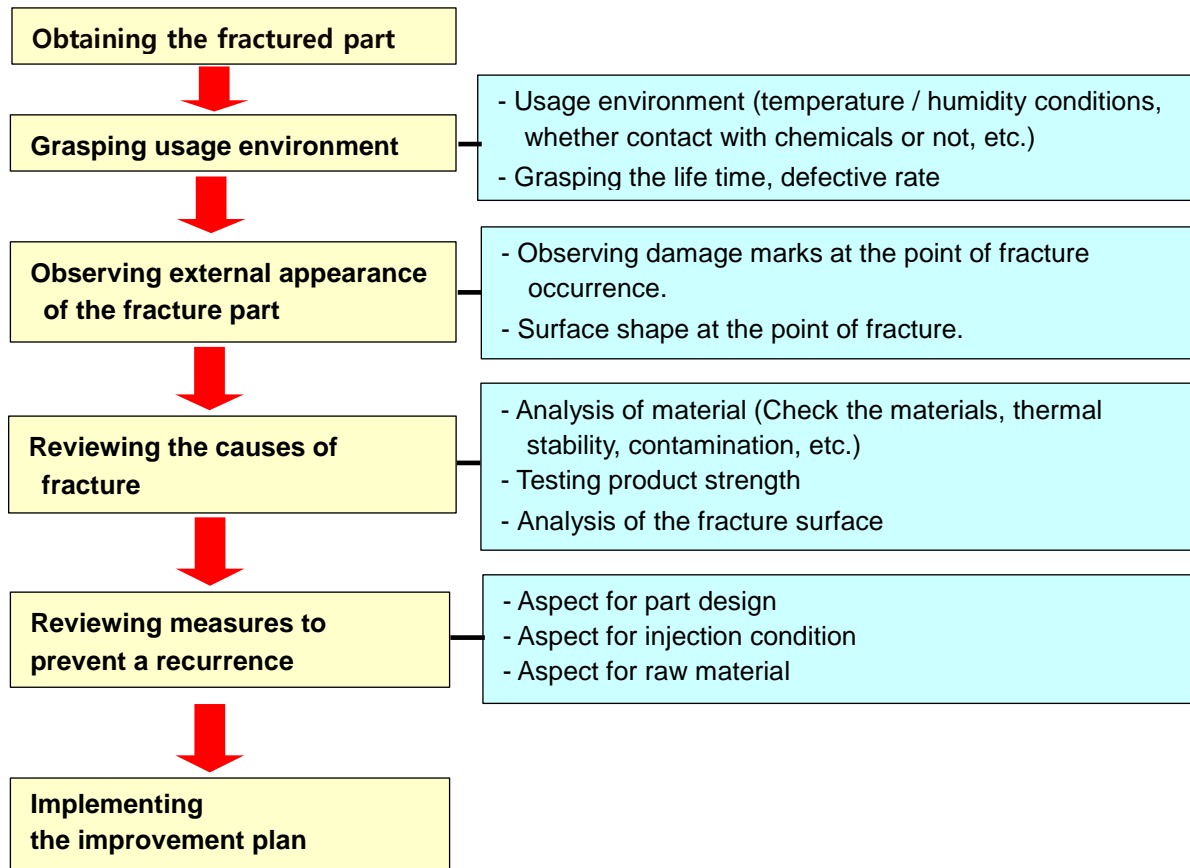
- 1) Fracture shape : The fracture surface is akin to a rice paddy cracked from a long drought.
- 2) Cause : Chemicals permeated plastic until the inner of the molded part, and weakened and decomposed finally, fracturing occurs.

[The sort of chemicals (acidic, basic) to weaken the strength are different according to each plastic material.]



2. Improvement plan for fracture of molded parts

(1) The fracture analysis flow



(2) Improvement plan for fracture of molded parts by main factor

1) Aspect for part design

- Design improvements in fracture occurrence site.
(Thickness and shape changes, providing sufficient venting)
- Roundness reinforcement at the sharp corner of the molded part.
- Control runner balance. (Stable charge induction by each cavity)
- Extend gate size and adjust location.
(Avoid matching the fractured part with weld line)

2) Aspect of injection molding condition

- Eliminate residual stress from molded parts by controlling injection pressure.
- Up mold temperature, injection pressure, and injection speed to enhance weld line strength.
- Set up proper injection pressure and speed to improve strength decline by unfilled status.
- Set up sufficient back pressure and holding pressure to prevent voids in the molded part.

3) Raw material aspect

- Select better materials and grade for fracturing.
(select with consideration of operating condition and design.)
- Keep raw materials dry (to prevent water absorption).

4) Others

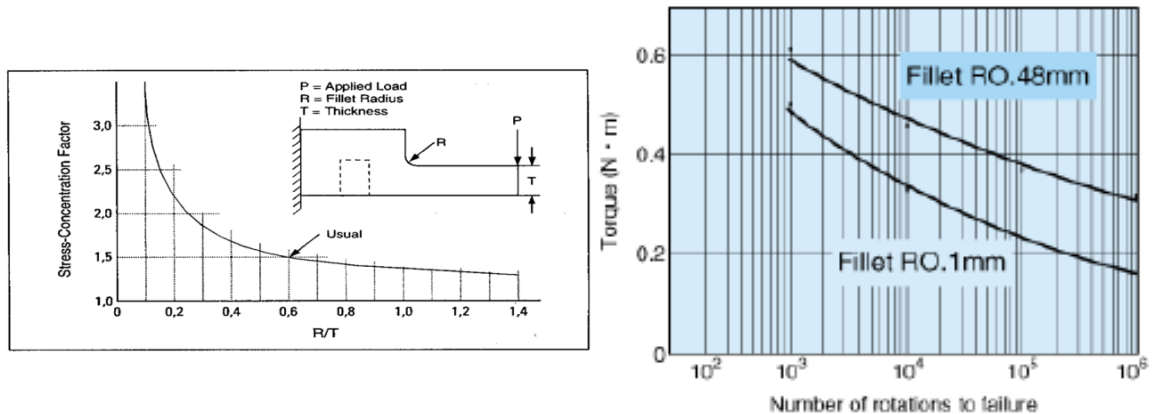
- Control molded parts to prevent exposure from chemicals
(to avoid chemical decomposition).

3. Occurrences and improvement plan according to fracture type

(1) Fracturing of sharp corner

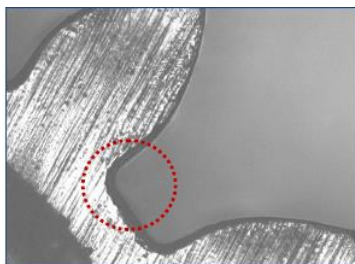
- 1) Fracturing cause : Fractured by insufficient roundness at the sharp corner.
- 2) Improvement plan : Increase roundness at the sharp corner.

[Reference : Effect of strength reinforcement by 'R' at the corner]

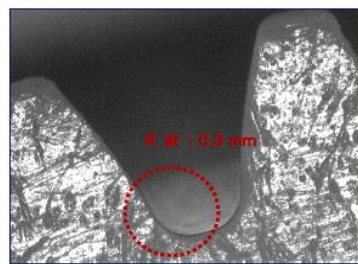


3) Cases of fracturing

- ① Fracturing due to insufficient roundness at gear teeth

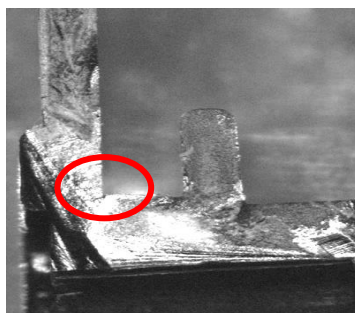


(Fractured gear tooth form)

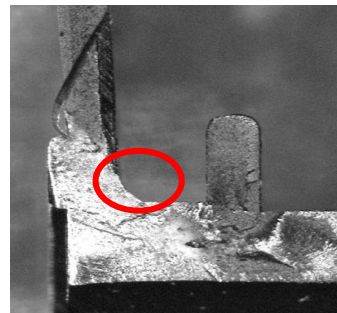


(Improved gear tooth form)

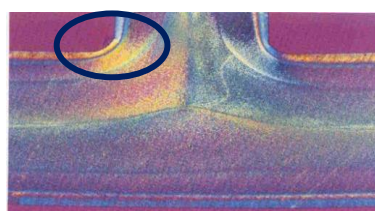
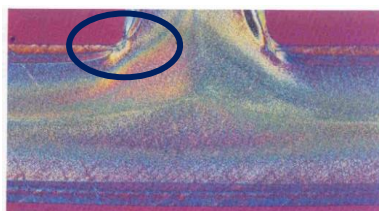
- ② Fracturing due to insufficient roundness at the sharp corner of case part



(Fractured case part)



(Improved case part)

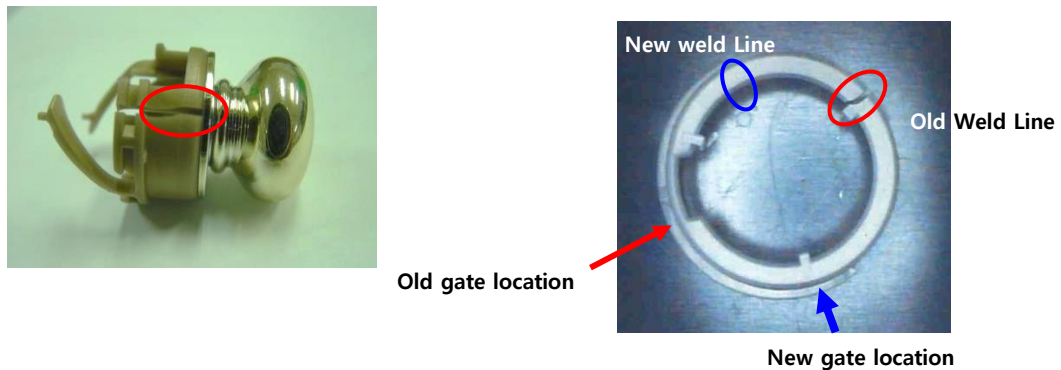


(2) Fracturing of weld line part

- 1) Fracturing cause : Fracturing due to existence of weld line at location of pressure.
- 2) Improvement plan : Adjust the location of weld line and enhance weld strength.
(Increase the resin temperature, mold temperature, etc.)

3) The case of fracturing

- ① Fracturing of weld line part of door handle



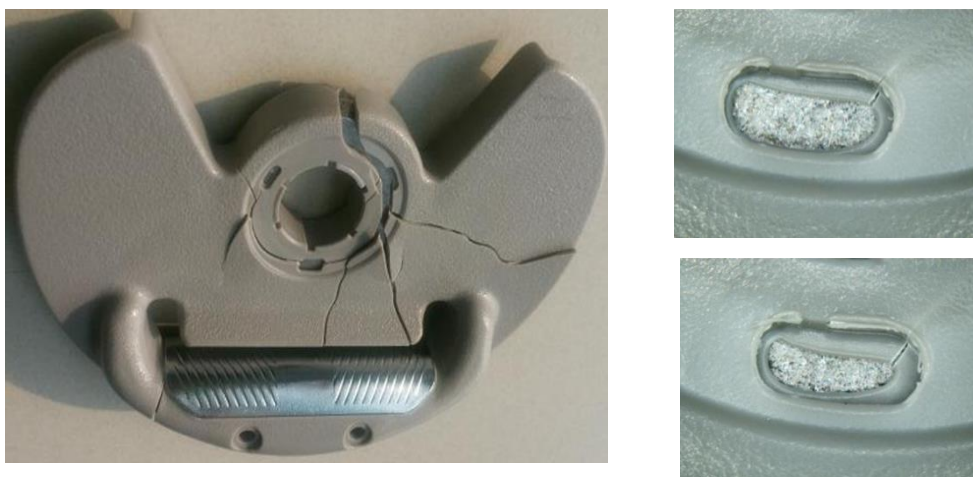
(Improve fracturing by moving the location of weld line by adjusting the gate location)

(3) Fracturing of metal insert part

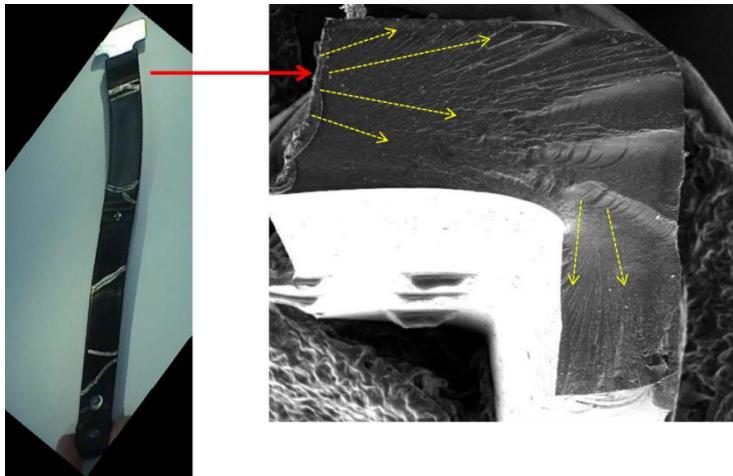
- 1) Fracturing cause : Caused by thinness of part and difference of coefficient of linear expansion between inserted metal and plastic.
- 2) Improvement plan : Increase thickness of part and minimizing the variation of thickness per part positions.

3) Fracturing cases

- ① Fracturing of D-Ring part on automotive seat belt



② Fracturing of automotive door checker part



③ Fracturing of metal insert screw part



(4) Fracturing due to pore occurrence

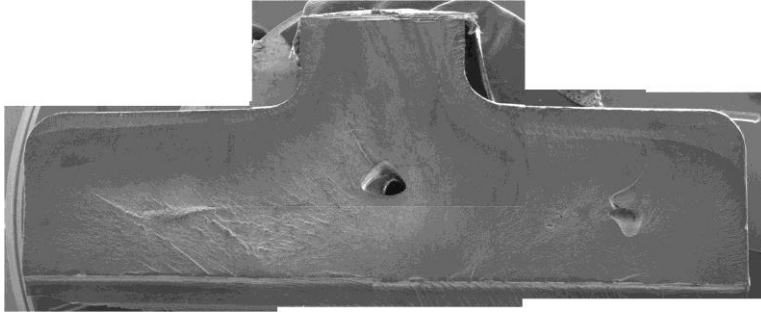
- 1) Fracturing cause : Decline of strength occurs because of pores located at the rear of part.
- 2) Improvement plan : Increase mold temperature, increase holding pressure/time, decrease resin temperature.

3) Fracturing cases

① Fracturing of automotive fuel tank plug part



- ② Fracturing due to void occurrence at the rear of general part



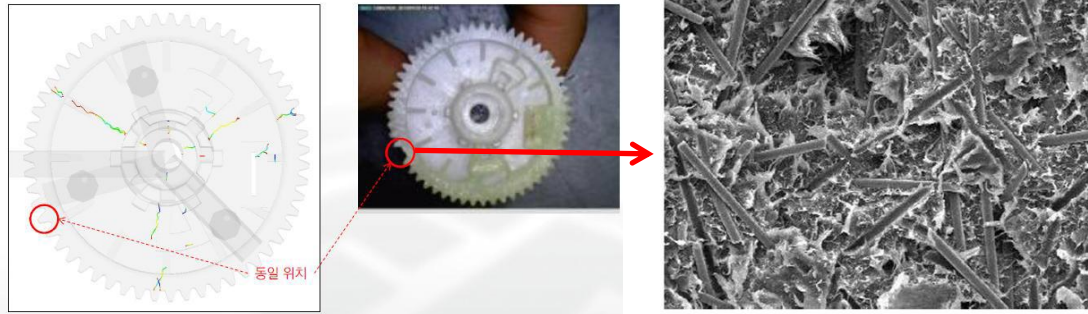
(5) Fracturing due to residual stress inside the part

- 1) Fracturing cause : Excess of residual stress by over-packing under low molding temperature.
- 2) Improvement plan : Increase mold and resin temperature and decrease injection pressure.
- 3) Fracturing case
 - ① The fracture of automotive window carrier plate part.
(Cracks occurs at the part of gate during ejection)

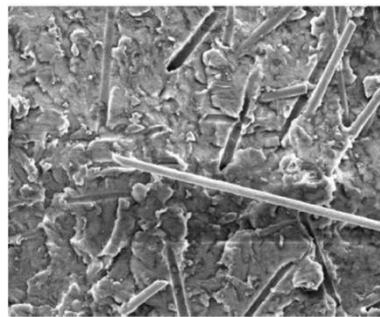
(6) Fracturing due to creep

- 1) Fracturing cause : Occurs when part can no longer endure external force after prolonged exposure.
- 2) Improvement plan : Change part design, reinforce weak areas.
- 3) Fracture cases

① Fracture during operation of gear part

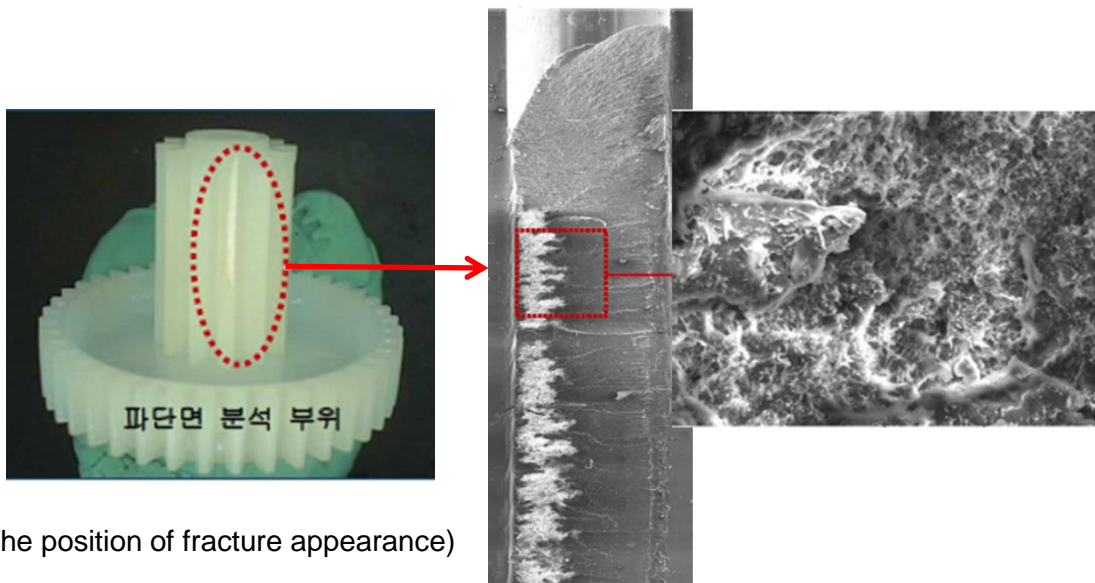


(Observing the tears at fracture appearance)



[Reference : Fracture appearance of sudden fracturing(smooth appearance)]

② Fracturing during operation of gear part (Creep damage by repeated load)



(The position of fracture appearance)

(Observe the tears at the fracture appearance)

(7) Fracturing due to chemical decomposition

1) Fracturing cause : Induced strength decline due to chemical decomposition on the surface of part.

2) Improvement plan : Prevent chemical contact.

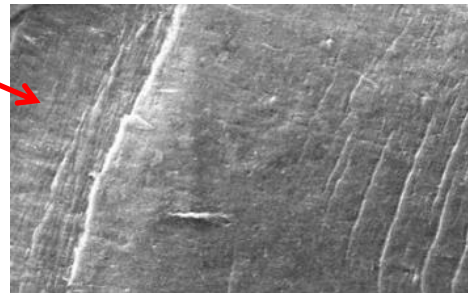
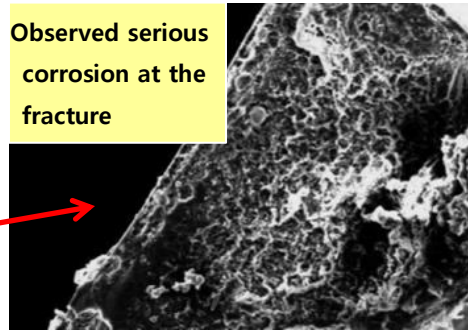
3) Fracturing cases

① The fracture of water purifier nipple (1)

Observed serious corrosion at the fracture appearance

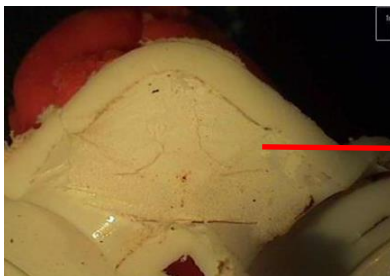


Observed serious corrosion at the fracture

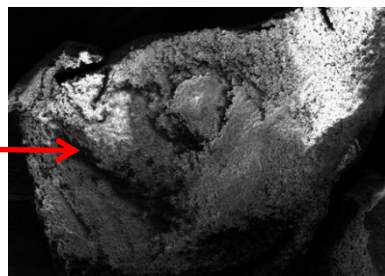


(There are no corrosion phenomenon at the fracture)

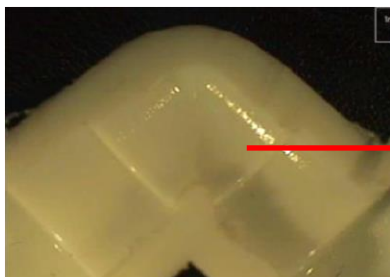
② The fracture of water purifier nipple (2)



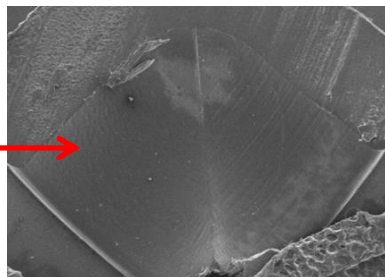
(Observed chemical corrosion on the surface)



(Serious surface corrosion)



(No chemical corrosion on the surface)



(Positive surface condition)

HQ

Mapo-daero 119 (Gongdeok-dong) Hyeoseong Bldg.
Mapo-gu, Seoul, Korea
Tel 82-2-707-6840 ~ 8, Telefax 82-2-714-9235

KEP Americas

106 North Denton Tap Road Suite 210-202 Coppell,
TX 75019, USA
Tel +1 888 KEPITAL, Telefax +1 888 537-3291

KEP Europe GmbH

Rheingaustrasse 190-196 D-65203 Wiesbaden, Germany
Tel +49 (0)611 962-7381, Telefax +49 (0)611 962-9132

KEP China

A1905, HongQiao Nanfeng Plaza, 100 Zunyi Road,
Shanghai, China
Tel +86 21 6237-1972, Telefax +86 21 6237-1803

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