

Fabrication

#12 Annealing

This brief gives advice for:

- **When to Anneal**
- **Equipment**
- **Procedures**
- **Equipment Suppliers**

When to Anneal

Annealing minimizes the effects of stress on items fabricated from ACRYLITE FF acrylic sheet. It alleviates most of the stress induced by line bending, thermoforming, screen printing, cementing, machining, buffing, flame polishing, and other fabrication operations. Annealing is recommended by CYRO in most cases.

The process reduces internal stresses in the sheet which can cause crazing (numerous tiny cracks in the material) when the acrylic comes in contact with solvents such as glass cleaners and some paints. Stress due to water absorption can also cause crazing. Annealing reduces to a minimum the likelihood that crazing or large scale cracking will occur. Also, studies have shown that annealing can increase bond strength by more than 50%.

Equipment

Forced Air Circulating Ovens

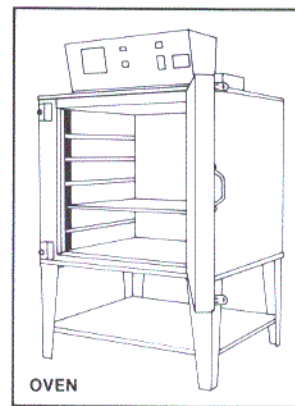
Anneal fabricated parts in forced air circulating ovens, assuring uniform temperatures and providing proper ventilation. Air velocity should be 150-250 feet per minute. Provide an oven controllable to within $\pm 10^{\circ}\text{F}$ ($\pm 6^{\circ}\text{C}$) to avoid uneven or excessive heating.

Select oven size carefully. Provide large doors for large parts and smaller doors to avoid heat loss when you're inserting small parts.

Temperature control selection affects oven efficiency. You can use percentage timer controls, which control the percent of the time heaters are on, but such controls may not provide uniform heat. Or, you can use proportional time controls with step switches to vary heater output, but these may produce uneven temperatures. Controllers monitoring

oven temperature and maintaining constant voltage into the heating elements seem to work best.

Commercial ovens designed for annealing and heating plastics are usually best. Some oven



suppliers are listed in the equipment suppliers section at the end of this brief.

You can anneal with a restaurant-type oven obtained from a restaurant supply house. Be sure the oven incorporates air circulation and accurate temperature control systems.

Procedures

To anneal ACRYLITE FF acrylic sheet, heat it to 180°F (80°C), just below the deflection temperature, and cool slowly. Heat one hour per millimeter of thickness—for thin sheet, at least two hours total.

Cooling times are generally shorter than heating times—see the chart on the next page. For sheet thicknesses above 8mm, cooling time in hours should equal thickness in millimeters divided by four. Cool slowly to avoid thermal stresses—the thicker the part, the slower the cooling rate.

Wait until oven temperature falls below 140°F (60°C) before removing items. Removing a part too soon can offset annealing's positive effects.

While annealing ACRYLITE FF sheet parts, support them to avoid stress. For example, a part's raised center section will need independent support—it can't be supported from the ends. Lack of support may inhibit relaxation or cause warpage.

Be sure parts are clean and dry before annealing. Remove paper masking to avoid baking it onto the material. Remove any spray masking, protective tape, or similar material. Plastic masking may remain in place.

If the only fabrication you have done is surface machining and you do not need to anneal cemented joints, heating time can be reduced. This reflects the fact that machining forms stresses only at and slightly below the surface—the entire sheet thickness needn't be annealed. Heat at least two hours; cool the same amount of time. If holes have been drilled entirely through the sheet, position the part so heated air flows through the hole.

If you are annealing following cementing, allow the part to sit at least six hours to avoid bubble formation resulting from rapid solvent evaporation in the joint.

SHEET THICKNESS VS. HEATING/COOLING TIME

| Thickness (in.) | Thickness (mm) | Heating Time (hours) | Cooling Time (hours) | Cooling Rate (°F/hr.) |
|-----------------|----------------|----------------------|----------------------|-----------------------|
| .080 | 2.0 | 2 | 2 | 28 |
| .098 | 2.5 | 2.5 | 2 | 28 |
| .118 | 3.0 | 3 | 2 | 28 |
| .125 | 3.2 | 3.2 | 2 | 28 |
| .177 | 4.5 | 4.5 | 2 | 28 |
| .187 | 4.7 | 4.7 | 2 | 28 |
| .220 | 5.6 | 5.6 | 2 | 28 |
| .236 | 6.0 | 6 | 2 | 28 |
| .375 | 9.5 | 9.5 | 2.5 | 22 |

Equipment Suppliers

CYRO Industries and CYRO Canada Inc. have found that equipment and supplies from the following companies work well with ACRYLITE FF sheet. Authorized ACRYLITE sheet distributors also offer equipment and supplies.

Ovens

| | |
|--|--|
| Despatch Oven Company P.O. Box 1320 Minneapolis, MN 55440 (612) 331-1873 | Trent, Inc. 201 Leverington Ave. Philadelphia, PA 19127 (215) 482-5000 |
|--|--|

The Grieve Company
500 Hart Road
Round Lake, IL 60073
(312) 546-8225

Additional Technical Information and Assistance

Technical Literature Available

For more detailed information, see your local Authorized ACRYLITE Sheet Distributor or contact CYRO Industries. Literature is available for these and other topics:

Physical Properties—

#1121—"Physical Properties of ACRYLITE FF Acrylic Sheet"

Fabrication Tech Briefs—

These cover individual operations of fabrication such as cutting, drilling, thermoforming, etc. Be sure to ask for the latest listing of available Tech Briefs from your ACRYLITE sheet distributor or CYRO Industries.

Application Tech Briefs—

These cover required fabrication operations for specific applications like glazing, signs, etc.

Technical Service

For complete technical assistance contact CYRO Industries, Technical Service:

CYRO Industries
25 Executive Blvd.
Orange, CT 06477
(203) 795-6081

In Canada:
CYRO Canada Inc.
6285 Northam Drive
Suite 100
Mississauga, Ontario L4V 1X5
(905) 677-1388
(800) 268-4743

Offices

For the name of your local Authorized Distributor call toll-free 1-800-631-5384 or contact the nearest CYRO office:

Rockaway, NJ 07866
100 Enterprise Drive
(973) 442-6130

San Ramon, CA 94583
3180 Crow Canyon Place
Suite 240
(510) 866-9300

Naperville, IL 60563
280 Shuman Blvd.
(630) 357-0822

Plano, TX 75074
101 East Park Blvd.
Suite 1039
(214) 424-6830

In Canada: (See above)

Fire Precautions:

ACRYLITE FF acrylic sheet is a combustible thermoplastic. Precautions should be taken to protect this material from flames and high heat sources. ACRYLITE FF acrylic sheet usually burns rapidly to completion if not extinguished. The products of combustion, if sufficient air is present, are carbon dioxide and water. However, in many fires sufficient air will not be available and toxic carbon monoxide will be formed, as it will from other common combustible materials. We urge good judgement in the use of this versatile material and recommend that building codes be followed carefully to assure it is used properly.

The combustibility test data for ACRYLITE FF acrylic sheet is: self-ignition temperature (ASTM-1929) is 830 degrees F, smoke density (ASTM D-2843) is 5%, and the rate of burning for 2mm thickness (ASTM D-635) is 4.3 cm per minute. While these data are based on small scale laboratory tests frequently referenced in various building codes, these tests do not duplicate actual fire conditions.

Important Notice: The information and statements herein are believed to be reliable but not to be construed as a warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE. Nothing herein is to be taken as permission, inducement or recommendation to practice any patented invention without a license.



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