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NASA TECH BRIEF

Acid Spray Technique Mills Aluminum Alloy Materials Without Immersion

The problem:

To develop a process for chemically milling aluminum alloy panels without immersing them in an etchant. The alkaline milling method presently used requires complete immersion in an etching bath. This is particularly cumbersome when milling large components.

The solution:

An acid spray machining technique, which allows large aluminum alloy parts to be chemically milled economically and without the need for large immersion baths.

How it's done:

Sample panels, constructed from 2219-T37 and 2014-T651 aluminum alloy, were chemically milled to depths of 0.500 inch using the spray technique. Across the surface of the 9-inch by 9-inch 2219-T37 specimens, the overall standard deviation in depth was ± 0.007 inch with a range of ± 0.012 inch. The 2014-T651 specimens showed less depth variation. By moving the specimens with respect to the spray, the uniformity of depth improved even more. The spray solution contains hydrochloric acid, acetic acid, and sodium dichromate.

To chemically mill the aluminum parts, 35 gallons of solution was sprayed over the surface of each sample. Maximum initial etch rates as high as 0.008 inch/minute were obtained, with the surface roughness within the allowable 125 rms. The average maximum etch rate was somewhat lower, however, because an average run is 30 minutes and the solution degenerates during this time. At the end of the run, the etch rate had dropped to approximately 0.001 inch/minute. Thus, the average maximum rates over the 30-minute period were 0.0047 ± 0.0019 inch/minute for alloy 2219-T37, and 0.0040 ± 0.0018 inch/minute for alloy 2014-T651.

The spray etching solution became essentially depleted after approximately 1.5 ounces of aluminum per gallon of solution had been removed from the samples. This results from using up the sodium dichromate and reducing the acid content. Replenishment of the solution components showed various degrees of restoring initial solution activity, but the total effect was generally inconclusive.

Notes:

1. The acid spray does not require artificial heating to initiate the etching process. It is probable, however, that the etch rate increases with temperature up to about 120°F.
2. Provisions should be made to draw the chemical solution alternately from two reservoirs, so that fresh solution is made ready as the solution in use is being depleted by the chemical reaction.
3. The ratio of the average undercut at a single edge to the depth of cut averaged about 0.6. The specimens etched in a horizontal position (sprayed from the underside) had an undercut ratio of 0.54 ± 0.08, which was lower than those etched at 45° or 90° from the horizontal. The mean ratio at these angles was 0.7 or greater.
4. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10463

Patent status:

No patent action is contemplated by NASA.

Source: George Dufour
of Lockheed Missiles and Space Co.
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Category 03