NASA TECH BRIEF

Marshall Space Flight Center

Semi-Organic Structural Adhesive for Aluminum

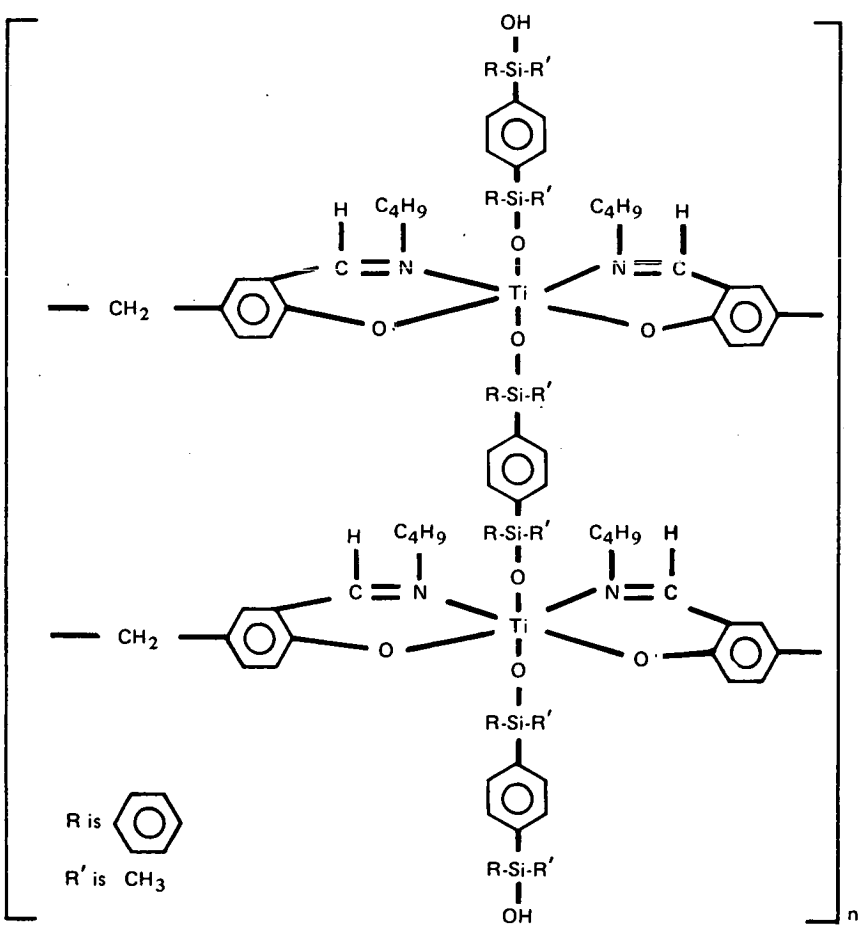
The problem:

There is a need for a structural adhesive for aluminum which will cure at a low temperature in a reasonable time.

The solution:

The adhesive formulation consists of (1) a titanium chelate ladder polymer with a ligand backbone and silanol substituents, (2) a reactive plasticizer, 4-4' bis (methyl phenyl hydroxysilyl) biphenyl ether, and (3) a cure accelerator, phenylsilanetriol.

The mixture polymerizes in situ for 65 hours at 170° C. Aluminum joints coupled with this adhesive exhibit 4.0 x 10^6 N/m^2 (580 psi) average tensile shear strength when tested at 250° C.



Titanium Chelate Ladder Polymer

(continued overleaf)

How it's done:

The first step is the preparation of the aluminum surface, by degreasing, followed by standard dichromate etch. Next the plasticized titanium chelate polymer is mixed. This consists of 80 parts by weight of the polymer whose structure is shown in the figure, mixed with 20 parts by weight 4-4' bis (methyl phenyl hydroxysilyl) biphenyl ether.

Then the adhesive is formulated by dissolving 71 parts by weight of plasticized titanium chelate polymer and 29 parts by weight phenylsilanetriol in 400 parts by volume acetone. The acetone solvent is removed by low-pressure evaporation.

After preheating the aluminum to 170° C, both joint surfaces are coated with 0.1 g of formulation per square inch (6.5 cm^2). When three minutes have elapsed, the joints are pressed together at 1 x 10^7 N/m^2 (1500 psi) for 30 minutes. The pressure is then released and the cure is continued for 65 hours. The temperature is kept at 170° C throughout.

Notes:

1. The curing time may be shortened to 24 hours by adding 1 part by volume of a 3% benzene solution of A-1100 (α-amino-propyl trimethoxysilane) to the 400 parts by volume of acetone. However, the strength of the joint will then be reduced to 2.8 x 10^6 N/m^2 (400 psi).
2. Some of the materials needed to make the adhesive may not be readily available. The original source publication gives detailed instructions for the synthesis of all such ingredients.
3. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&PS-TU
   Marshall Space Flight Center, Alabama 35812
   Reference: B73-10071

Patent status:

NASA has decided not to apply for a patent.

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under contract to
Marshall Space Flight Center
(MFS-21328)