

## **BONDIT™ A-3, A-43, C-6, C-31, C-52, C-21**

### **Primer Selection and Engineering Application Notes\***

1) These primers and adhesion promoters are very low viscosity, low to medium concentration silane formulations with a wide range of functionality.

The A-3 was developed as a high moisture resistant, one part, one coat, ambient or thermal cure primer for metal with our B-4811 semi-rigid epoxy as an over coat for cathodic protection.

Other materials, such as castable PU, Neoprene, EPDM, or Nitrile are overmolded to the B-4811 using either the A-3 primer which provides very high chemical resistant bonds to metals and glass.

LDPE has also been injection molded to the A-3/B-4811 system using primer C-21 and a RELTEK proprietary LDPE blend developed for a new submarine program, which passed a twenty-year accelerated life qualification testing (ALT).

The A-3/B-4811 primer/adhesive system provides for excellent transition from a rigid substrate to a high thermal expansion polymer.

2) Experiments have shown the combination of metal/primer/epoxy coating is synergistic and that produced exceptional cathodic resistance. It has also been shown to have exceptional acid resistance, and both boiling water and high 95%/95°C resistance on metal and glass. That system was the only polymer coating system to pass U. S. Navy cathodic disbondment testing for submarine applications in 1991. ALT included 7 months exposure in 66°C artificial seawater with daily thermal shock to 6°C and monthly pressure cycling to 2500 PSI. It has resisted breakdown when placed directly in a high power plasma beam in the formation of a laser beam used for welding metal on cars. The system has qualified as an adhesive and coating and been successfully employed in a number of Navy programs with testing to -50°C.

3) The A-3 is used with B-482 it to seal large magnesium sonar elements from corrosion from seawater in a cathodically active submarine environment demonstrating long life.

4) The A-3/B-4811 system is used to directly seal semiconductor chips exposed in a high pH, biologically active, water solution as part of a microbiological sensor system product. The adhesive and sealing performance results have "exceeded wildest expectations."

5) From all the experience in using A-3 with adhesives such as B-4811 semi rigid epoxy, HM-502 thermoplastic adhesive (PE/Acrylic emulsion), and HM-505 thermoplastic adhesive (PE/Acrylic solvent based and solid hotmelt) we can generally say the A-3 has exceptional

moisture resistance as a primer for metals, glass, ceramics, many polyolefins and engineering plastics.

6) Twenty year ALT in elevated temperature seawater showed no loss of shear adhesion in bonding HDPE/HDPE and 50% increase in peel strength in bonding HDPE/Polyolefin shrink tubing using A-3 primer/HM-502 thermoplastic adhesive.

7) As a general rule, from the chemical design, A-3 is the most moisture resistant primer followed by A-43 and then C-6. That is most apparent on hydrophilic substrates, particularly metals. It is much less noticeable on polymer to polymer interfaces because they tend to form bonds other than oxane which is easily hydrolyzed. A-43, C-6 and C-21 are higher concentration and higher reactivity, especially amine functionality, than A-3. Hence, A-43 bond strengths are expected to be typically higher with polymer interfaces compared with A-3, require only one, or maybe two, coats compared to A-3 which requires three to four on some polymers, will be less hydrophobic than A-3, and will take a little longer to cure than A-3.

8) The primers are IPA based for solvent and low in VOC. A new VOC exempt solvent is available, TBA, that may be substituted for the IPA. All ingredients of RELTEK formulations are TSCA listed. None of RELTEK formulations are listed.

9) For plastics, bond strengths tend to be very good when using the A-3 primer and A-43. Glass filled Nylon 66 produced failure of the nylon substrate using A-3 primer/HM-502 thermoplastic adhesive.

10) All the polyethylenes, including UHMW, exhibit shear strengths ranging from 300 PSI -- using the B-4X and B-536 series epoxies -- to 500 - 900 PSI -- using the HM-502 and HM-505 thermoplastic adhesives. The same result is obtained with POM (Acetal, Delrin). Adhesion to some TPE's has been demonstrated.

11) Adhesion to Silicon, Fluoropolymers such as ETFE (Tefzel) and PVDF, PPO (Noryl), Polyesters such as PBT (Vaylox) and PET (Ertlayte, Hytrel), PPS (Ryton, Konduit), PolyEtherImide (Ultem), PEEK, PolyAmide-Imide (Torlon), PolyImide (Vespel), and some styrene blends has been demonstrated with A-3 and A-43 as a primer.

12) Virgin PP/A-3/B-5/steel produced sheer strength in testing of 543 PSI. PVDF/A-3/B-5/PVDF yielded at 641 PSI.

13) Bond joints of rigid PVC/PVC white and gray, ABS/ABS white and black, and PVC gray / ABS white produced substrate failure in lap shear tests at below freezing and ambient, and mixed substrate & cohesive failure at 140°F using A-43 primer with B-45TH flexible epoxy. B-45TH epoxy bonds ABS/PVC without primer to produce substrate failure.

14) The A-3/B-4811 system is used to bond Delrin, Ultem, PPS and PPO to iron stator coils in electric motors, and forms a high chemical and moisture resistant bond. These motors have been successfully operated inside natural gas lines coming direct from wells containing corrosive Sulfur.

15) The A-3/B-482 system is used to fill and repair cracks in large PP tanks that hold caustic and acid baths operating at ambient to 40°C.

- 16) The A-43/HM-505 and B-45TH are used to bond PBT, PEEK, and fiberglass to Mylar gloss surface and PU foam with substrate failure of the PU, and mixed cohesive and Mylar (polyester) substrate failure.
- 17) The A-3 is used to prime metal for molding with fluoro silicon PPS and produces high bond strengths. The project is deployed in space.
- 18) The A-3/HM-502 system is used for bonding UHMW to stainless steel for continuous submersion in hydroelectric dams.
- 19) The A-3/HM-505 is used to bond leather to UHMW for an auto-racing product with bulk failure of the leather in peel tests.
- 20) Nylon fabric and Gorex fabric peel strength reached 11 PLI using A-3/HM-505 as part of a project for the garment industries.
- 21) An offshore oil equipment supplier uses the A-3/HM-505 system to bond molded PU parts to flexible PVC substrates for use in high shear/high peel wear surface applications on cable deployment shivs.
- 22) A Canadian defense contractor identified the A-3 and C-6 as the only primers to work successfully on highly plasticized PVC wire and retain the bond over a period of time.
- 23) Peel strength for HDPE / castable PU (PRC 1592 with high modulus) ranged from 7.6 to 11.3 PLI using only one coat of A-43 primer on the HDPE, compared with A-3 in two coats which produced 1.4 PLI in the same test.
- 24) Customers use the A-3 as a primer on various metals including aluminum, brass, gold and titanium for molding B. F. Goodrich Estane TPU. They report bulk failure of the TPU in testing immediately after molding and no loss of adhesion after months of deployment at sea. The contractor for a U.S. Navy funded program selected A-3 as the best primer for Estane molding to stainless steel and Monel. A major cable assembly producer uses A-3 to prime silicon rubber, followed with C-31 primer and overmolding with neoprene rubber. That produces bulk failure of the silicon rubber in peel tests. They also use A-43 as a primer for molding neoprene and cast PU molding to LDPE and metal substrates.
- 25) The A-3 and A-43 primers are used for cable termination applications to prime neoprene for castable PU overmolding, that yields bulk rubber failure.
- 26) Major U.S. and European cable companies are using the A-3 in priming HDPE and metals with PU and PE molding for their molded cable systems. These companies, some of the largest in the industry, use the A-3 with HM-502, HM-505, and B-4811 for sealing high voltage fiber optic terminations deployed to full ocean depth (17,000 PSI) with a twenty-year life rating. Bonds are to the fiber, fiber buffer, MDPE, ceramic and stainless steel. The adhesive systems have provided both sealing and blocking high voltage corona. The A-3, B-4811 and HM-505 systems are also used for fiber optic cable / sensor encapsulation.
- 27) A-3 and A-43 have been used as a primer on Aflas (peroxide cure), EPDM (peroxide cure), HSN (peroxide cure), Nitrile (sulfur and peroxide cure) and bonded with B-45TH and B-4682TH flexible epoxy adhesive.

28) Thermoset plastics demonstrate generally favorable results from chemical bonding with A-3 and A-43. These typically produce substrate failure, or bulk failure of adhesive in lap shear tests. Cohesive bonds are produced with polyolefin shrink tubing, epoxy and urethane.

29) Thermoplastics demonstrate favorable results from chemical bonding with A-3 and A-43. Testing shows typical lap shear (ASTM D3163) strengths of 300 PSI to 900 PSI when used with our HM 505 hot melt adhesive or B-4X series adhesives, sealants, potting and coating formulations (with and without primers). Tests have included ABS, PVC, Nylon, PVDF, PPO, PPS, PET, HDPE, UHMWPE, PEEK, PET, ETFE, PEI, PI, POM (Acetal), PAI, PP.

30) Thermoplastic polyurethane (TPU) shows favorable field results with A-3; sensitive to injection molding parameters. Customers report cohesive failure in testing, with A-3 used as primer on metals for molding TPU (Estane by B.F. Goodrich) and cohesive bond failure of the TPU after months of exposure in the ocean. Similar results can be expected from TPR applications, depending most on the block polymer. Specific material testing is recommended for each application to ensure compatibility.

31) Plasticized PVC shows favorable results with A-3 and C-6, mostly A-3 with castable PU and epoxy potting and overmolds. A-43 is also excellent and affords a one-coat application. Plasticized PVC is difficult to bond to due to the plasticizers used in the plastic, whose job it is to break bonds. That's how naturally rigid PVC is made flexible. The plasticizers break up the crystalline structure, which also break the bonds formed by adhesives. This is overcome by the use of the A and C products.

32) BONDIT™ C-52 primer/adhesion promoter provides cohesive bonds for molding polyethylene to metals and ceramics, including brass and aluminum. The bonds are stronger than the polyethylene.

33) Rubber. A-3 has worked well on most rubbers, particularly peroxide cure types. A-43 is particularly formulated for peroxide, sulfur and metal cure systems. HM 505 hotmelt adhesive works well in combination with A-3 and A-43 to form cohesive bonds with most rubbers. The B-4X epoxy cure series bonds well with and without primer to EPDM, neoprene and butyl rubbers.

34) RELTEK normal test procedure is to grit blast all surfaces with #100 AlOx clean grit, wash with isopropyl alcohol, prime with one to four coats of primer, ambient cure 30 - 40 minutes or 100°C cure 10 - 15 minutes, followed by application of adhesive and assembly of bond joint pressed together with finger pressure, or clamped with spring clamps, and using 0.007" copper wire for adhesive gap control.

35) The cure system of an adhesive or overmold material will have a great deal to do with the environmental resistance of the bond. For instance, the A-3/HM-505 system will provide excellent moisture resistance including boiling water but is poor with acoustic oils, compared with the use of the A-3/B-4811 system which has very high moisture and oil resistance, and with the A-3/B-4X system which has moderate moisture and oil resistance. The B-4X adhesive, sealant, potting epoxy and coatings are specifically formulated for high moisture, oil, and acid and alkyl resistance, with excellent adhesion to a wide range of substrates — with and without primer.

\* These are historical examples, some of which utilized the now discontinued B-1 or B-9X series products. Those examples have been modified for illustration purposes by replacing references to the discontinued products by references to the equivalent new and replacement products in such applications. The BONDIT B-4811 replaced the obsolete B-1. The B-4X flexible epoxy series replaced the obsolete B-9X flexible epoxy series. The new products are based on proprietary modern resin technology and curing methods that have resulted in performance improvement over the discontinued products. The B-1 and B-9X series are no longer manufactured and no stock is available.