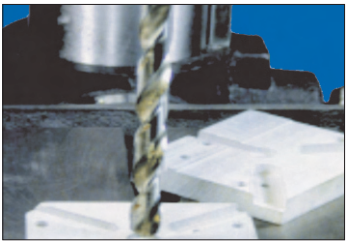
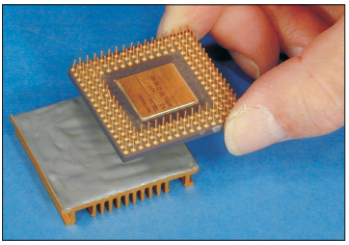
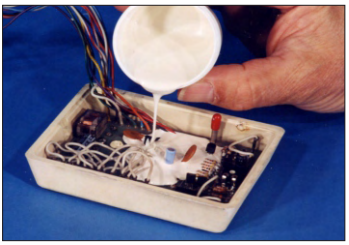
VOLUME 14
NUMBER 60

# HIGH TEMP. MATERIALS
# INSTRUCTIONAL HANDBOOK





COTRONICS CORP

High Temperature Specialty Materials Since 1971

# COTRONICS' HIGH TEMPERATURE EPOXY-BASED ADHESIVE PROPERTIES

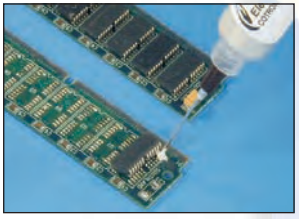
| FEATURES | CONDUCTIVE | | 500ºF ROOM TEMP. CURES | | | | 600ºF ULTRA TEMP | | | MACHINABLE | | ONE PART |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cat No.** | **120** | **132** | **4461** | **4525** | **4538** | **7050** | **4460** | **4700** | **4703** | **4540** | **454B** | **4420** |
| **Properties** | Super Electrical Conductive | High Thermal Conductive | Low Viscosity Adhesive and Coating | General purpose Adhesive and Potting | Super Flexible Stress Free Adhesive | Nylon Bonder Bonds Most Surfaces | Hi-Temp. Low Viscosity and Coating | Hi-Temp Gen. Purpose Adhesive and Casting | Ultra Temp. Tooling Repairs | Machinable Aluminum Casting and Repairs | Machinable Non-Sag Putty Adhesive | One Component Structural |
| Maximum Temp | 500ºF | 500ºF | 500ºF | 500ºF | 450ºF | 450ºF | 600ºF | 600ºF | 650ºF | 500ºF | 450ºF | 450ºF |
| Components - Color | 2-Silver | 2-Silver | 2-Amber | 2-Black | 2-Tan | 2-Black | 2-Amber | 2-Black | 2-Black | 2-Silver | 2-Silver | 1-Grey |
| Viscosity (cps) | 25,000 | 36,500 | 600 | 25,000 | 10,000 | 20,000 | 600 | 40,000 | 50,000 | 30,000 | 100,000 | Paste |
| Density (gm/cc) | 3.8 | 1.8 | 1.1 | 1.7 | 1 | 1.3 | 1.1 | 1.8 | 1.8 | 1.9 | 1.9 | 1.2 |
| Hardness (Shore 'D') | 70 | 75 | 90 | 90 | 60-80A | 70 | 90 | 94 | 95 | 80 | 80 | 75 |
| Tensile Strength (psi) | 6,500 | 7,200 | 9,500 | 10,000 | 6,000 | 5,000 | 10,300 | 11,100 | 11,800 | 10,000 | 10,000 | 7,000 |
| Thermal Cond. (BTU-in./Hr. $Ft^2$ °F) | 50 | 40 | 4 | 13 | 7 | 4.5 | 4 | 13 | 18 | 35 | 35 | 8 |
| Thermal Expansion (x $10^{-5}$/°C) | 4.1 | 4.1 | 5.4 | 3.3 | N/A | 4.8 | 5.4 | 3.4 | 3.9 | 4.1 | 4.1 | 3.3 |
| Dielectric Strength (volts/mil) | N/A | 100 | 450 | 450 | 450 | 400 | 500 | 550 | 450 | 100 | 100 | 400 |
| Volume Resistivity (ohm-cm) | 0.00008 | $10^6$ | $10^{13}$ | $10^{15}$ | $10^{14}$ | $10^{14}$ | $10^{14}$ | $10^{14}$ | $10^{10}$ | $10^8$ | $10^{10}$ | $10^{10}$ |
| Heat Distortion | 210ºC | 210ºC | 210ºC | 210ºC | 75ºC | 75ºC | 260ºC | 300ºC | 320ºC | 225ºC | 200ºC | 175ºC |
| Elongation (%) | 0.2 | 0.2 | 5 | 2 | 12-100 | 3 | 5 | 2 | 2 | 1.2 | 1.2 | 1.5 |
| Thermal Stability (%) (1000 hr. @ 200°C) | 0.2 | 0.2 | 0.2 | 0.05 | 0.5 | 0.5 | 0.1 | 0.1 | 0.02 | 0.5 | 0.5 | 0.6 |
| Shrinkage (% max.) | 0.2 | 0.8 | 0.8 | 0.2 | 0.8 | 0.8 | 0.5 | 0.2 | 0.1 | 0.1 | 0.2 | 0.3 |
| Moisture Absorption (% 30 days) | 0.2 | 0.2 | 0.15 | 0.1 | 0.5 | 0.2 | 0.1 | 0.02 | 0.15 | 0.2 | 0.2 | 0.5 |
| Mix Ratio (by weight) | 100/3.4 | 100/27 | 100/17 | 100/8 | 100/120 | 100/10 | 100/80 | 100/28 | 100/22 | 100/9 | 100/11 | N/A |
| Working Time for 25 gms. (Mins. @ 75°F) | 30 | 30 | 30 | 30 | 90 | 30 | N/A | N/A | N/A | 30 | 30 | N/A |
| Cure (Hr. @ 75 °F) | 16-24 | 16-24 | 16-24 | 16-24 | 16-24 | 4-16 | N/A | N/A | N/A | 16-24 | 16-24 | N/A |
| Cure (Mins. @ 250°F) | 7 | 5 | 5 | 5 | 60 | 1-2 | 4 Hrs. | 4 Hrs. | 4-6 Hrs. | 8 | 10 | 30 |
| Page No. | 10 | 12 | 7 | 5 | 9 | 15 | 6 | 8 | 8 | 17 | 39 | 16 |

***Pre-Measured Kits***

***Epox-Eez*** *in 10 gm. and 25 gm. units* *see page 19*

# Adhesives, Potting and Conductive Epoxies

Bonding



Conductive

Potting

**Material Selection**

Choose the material that most closely matches the specific details of your application. The details would include the temperature range, electrical and thermal properties, thermal expansion, viscosity, hardness and any process limitation that you may have (ie. cure procedures)

**Preparation**

1. Clean surfaces of all grease, oil, dirt, old coatings, rust, etc. (For best results use Resbond 105RS Solvent). Roughen surface to improve adhesion.
2. Re-stir all Resins and Hardeners before measuring to insure a uniform, homogeneous product. Warming resins to 100°F (38°C ) - 120°F (49°C) will reduce the viscosity to ease mixing.

**Mix Ratio**

***Note:*** *All measurements are by weight.*

1. One and two component systems: re-mix thoroughly, apply and heat cure as directed.
2. Two component systems: check the product label for the exact mix ratio, all mix ratios are by weight. Weigh out the resin and the hardener into separate clean containers.

***Note:*** *Weight required = (total weight) - (weight of container)*

3. Combine the resin and hardener. Mix slowly and thoroughly. Do not whip air into the mix. Make sure to scrape the sides and walls of the container to insure a complete mix.

***Caution: Mixing batches over 50-100 grams can create excessive heat in some formulations.***

**Air Removal and Vacuum Degassing**

Warming resin and letting the mixture stand several minutes before use will normally remove most of the entrapped air. *Note: the use of warmed resin may reduce working time.*
Vacuum degassing should be employed for most critical applications.

**Applying The Adhesives**

Apply with a trowel or with a dispensing syringe. Bond lines should be between 0.005" - 0.010" for best results. *Disposable syringes are available from Cotronics.*

**Potting and Casting Applications**

Slowly, pour in a thin stream, to allow air to escape. The material should be able to flow around and under the components being potted. ***Note:*** *Pouring too fast may trap air pockets.*

**Curing**

Follow the cure directions listed on the product label.

**Post Cure**

*Post curing will result in optimum properties (strength; chemical, solvent and moisture resistance, conductivity and resistivity, etc.).*

1. Consult the label for specific instructions.
2. Recommended cure cycle 1-2 hours at 250°F (120°C) and 1-2 hours at 350°F (175°C).

**Clean Up**

Clean up resin/hardener prior to curing with solvents (Denatured Alcohol).

**Safety**

Read MSDS carefully before use. Prolonged skin contact may cause irritation.
Uncured materials can be washed from the skin with a mild soap and water.
If any material contacts eyes, flush continuously with water and consult a physician immediately.

# Cotronics High Temp. Ceramic Adhesive Properties

| BASE | ALUMINA | | | | ZIRCON | | MICA | MAGNESIA | SILICA | | GRAPHITE | METALLIC | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cat. No. | 901 | 903HP | 989 | 920 | 904 | 940 | 907 | 919 | 940LE | 7030 | 931 | 950 | 952 | 954 |
| Type | Fiber Base | Hi-Bond Strength | General Purpose | Thermally Cond. | Ultra Temp | Fast Set | Industrial Strength | High Resist. | Low Exp. | High Strength | Graphite | Alum. Metal | Nickel Metal | Stainless Steel |
| Service Temp. (°F) | 2600 | 3250 | 3000 | 3000 | 4000 | 2000 | 2300 | 2800 | 2500 | 1800 | 5400 | 1200 | 2000 | 2000 |
| Base | $Al_2O_3$ | $Al_2O_3$ | $Al_2O_3$ | $Al_2O_3$ | $ZrO_2$ | Zircon | Mica | MgO | $SiO_2$ | $SiO_2$ | Carbon | Al | Nickel | 316SS |
| Compressive Strength (psi) | 1200 | 7000 | 3000 | 4500 | 6000 | 4000 | 3500 | 4500 | 3200 | 5000 | 3000 | 4000 | 5000 | 4500 |
| Flexural Strength (psi) | 600 | 3500 | 1100 | 450 | 3000 | 1800 | 1250 | 450 | 2100 | 1450 | 1500 | 3000 | 3000 | 2500 |
| Thermal Exp. ($10^{-6}$/°F) | 4 | 4 | 4.5 | 4.5 | 4.1 | 4.5 | 4.5 | 2.6 | 0.3 | 7.5 | 4.1 | 10 | 4 | 10 |
| Thermal Cond. (BTU in/ Hr °F $Ft^2$) | 2 | 40 | 15 | 15 | 10 | 8 | 6 | 4 | 10 | 8.3 | 60 | 44 | 14 | 10 |
| Dielectric Strength (volts/mil) | 200 | 250 | 200 | 270 | 250 | 125 | 300 | 270 | 200 | 100 | COND. | COND. | COND. | COND. |
| Volume Resistivity (ohm-cm) | $10^{12}$ | $10^{10}$ | $10^{8}$ | $10^{11}$ | $10^{8}$ | $10^{8}$ | $10^{9}$ | $10^{11}$ | $10^{11}$ | $10^{9}$ | COND. | COND. | COND. | COND. |
| Consistency | Paint | Paint | Paint | Paste | Paste | Paste | Paste | Paste | Paste | Paste | Paste | Paint | Paste | Paste |

***970N Kit Ceramic Adhesive Sampler Kit includes 4 ounces each of 901, 919, 940, 907GF, 989, 950 & 7030***

***It is the ideal choice for simplifying product selection***

***Manufactured in accordance with ISO 9000***

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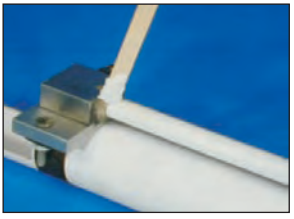


Bonding

Sealing

Protecting

***Use the 970N Selector Kit for product evaluation and selection. Development work and custom formulations are available upon request.***

### Selection Criteria

1. Select an adhesive with a thermal expansion as close as possible to the materials being bonded.
2. Check for the maximum temperature, electrical properties and the bond strength required.

### Surface Preparation

***For Non-porous Materials*** Clean dirt, oils and greases from the substrates surface. Mechanically roughen surfaces prior to bonding.

***Porous Materials*** Clean surface of loose dirt and dust. Moisten the surface to be bonded with a solution of 50% ceramic adhesive thinner and 50% water.

### Adhesive Preparation

1. One and two component systems: re-mix all materials thoroughly prior to use.
2. Two component systems: weight out powder and activator according to the mix ratio on the mix ratio on the label. ***Note:*** *weight required = (total weight - weight of container)*

*Mix thoroughly. Do not whip air into the mix.*

### Apply Adhesive

1. Apply by spatula, brush or by dipping. Completely wet the surfaces being bonded.
2. Immediately press surfaces together. If necessary, clamp or fix materials to maintain uniform distance while curing. Best results are obtained with gap widths of 0.005" to 0.010".
3. Excess adhesive can be removed with a damp rag. Discard excess materials.

### Curing

***Note:*** *Always follow the product's specific instructions as shown on the product label.*

1. Let joint air set for 1- 4 hours.
2. Cure for a minimum of 2 hours at 200°F (90°C).
3. Avoid excessively fast heating. It will cause adhesive to bubble and form a weak bond.

***Note:*** *These products will not out-gas after a complete cure.*

### Post Cure

*A second cure will provide maximum strength, solvent and moisture resistance*

1. Consult the product label for specific instructions.
2. Recommended post cure: 1 hour at 250°F and 1 hour at 400°F - 600°F.

### Potting

For potting directions refer to the instructions for ceramic potting materials (page 6).

### Coating

One Component Systems may also be used to form Ceramic Coatings.

1. Thin the adhesive use the thinner developed for use with each specific adhesive.
2. Make a solution by mixing 50% ceramic thinner and 50% water.
3. Brush or Spray on a thin coat. Air dry coating. Re-apply. Repeat until desired thickness is obtained.
4. Follow cure instructions as required on the product label.

***Note:*** *These products will not out-gas after a complete cure.*

# DURAPOT™ POTTING COMPOUNDS

These Epoxy and Ceramic, High Temp. Potting Compounds offer high temp. stability and excellent chemical, solvent and electrical resistance. They are the ideal choice for the most demanding Electronic, Industrial, Instrumentation Military, etc. Applications.

### Ceramic Potting Directions

1. Thoroughly re-mix the powder supplied. All measurements are by weight. Weigh out the base (powder) and activator (liquid) into clean mixing containers. Check product label for specific mix ratios and whether activator or water is used in your system. For fine details add 1% - 2% extra activator, or water, to increase fluidity. Working time will be approximately 10 - 20 minutes at 70°F (20°C).
***Note:*** *Adding too much activator will weaken the cured result.*

2. Mix to a heavy paste-like consistency. This will produce parts with optimum strength and minimum shrinkage. The paste like mixture will flow when vibration is applied to the mold.

3. Pour the ceramic mixture into the casting shell working it in and around the components. Overfill the mold slightly. Vibrate the mold to remove air bubbles. (1- 5 minutes should be sufficient). After 20 minutes remove any excess material with a trowel.
***Hint:*** *familiarize yourself with these materials by making a trial potting in a plastic drinking cup before making an actual part. A part 2" dia. x 1" high is ideal for testing.*

4. Cure for 16 - 24 hrs. at room temp. Post cure for 2 hrs. at 225°F. This will remove moisture and add strength to the cured casting. Additional post curing between 600°F - 900°F will increase the strength and improve the moisture resistance of the potting compound.
***Notes:*** *Full Electrical Properties are obtained only after the Moisture is Removed.*
*Durapot Ceramics are vacuum stable and will not out gas after curing.*

5. The potted material will be porous and can be sealed (against moisture) with Duraseal 1529 or Resbond 797 (call Cotronics for details).

### Epoxy Potting Directions

1. Clean the surfaces exposed to the potting compound insuring that all surfaces to be bonded are free of grease, oil, dirt, etc.

2. Re-stir resins and hardeners before mixing to insure a uniform homogeneous product. Warming resins to 100°F - 120°F will reduce the material's viscosity and facilitate handling.
***Note:*** *Warming the resins will reduce working time of the potting compound.*

3. Weigh out the resin and hardener into clean, separate containers. All mix ratios are weight ratios. Specific mix ratios are given on product labels.

4. Mix slowly and thoroughly to insure a homogeneous mix. Make sure to scrape sides and walls of container to insure a complete mix. *Do not whip air into the mix.*

5. Air Removal: Cotronics' potting compounds contain additives that minimize air entrapment. Additional air can be removed by warming the resin to 100°F-120°F and letting it stand for several minutes will normally remove most of the remaining entrapped air.

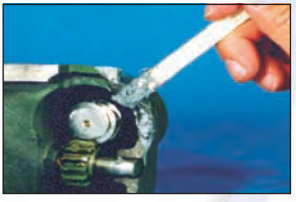
6. Potting: if a mold release is required use Replicast 101MR for best results. Pour mixture slowly, in a thin stream to allow entrapped air to escape. Allow the potting compound to flow around and under the components being potted. A fast pour will entrap air. Clean any excess uncured epoxy with Resbond 105RS surface cleaner.

7. Recommended curing instructions for each formulation can be found on the product's label. General curing instructions: heat for 1-2 hours at 250°F (120°C) and 1 hour at 350°F (175°C).

***Note:*** *Optimum high temperature properties (strength; chemical, solvent and moisture resistance; electrical and thermal conductivity and/or resistance) will only be obtained after a post cure.*

# DURABOND™ EPOXY AND CERAMIC PUTTIES

These smooth, creamy putties combine the high temperature performance of Cotronics' specialty formulations with easy to use, dispensing systems. Perfect for on site repairs.
Choose from systems based on: Machinable Aluminum (**500°F** - RK454 or **1200°F** - 7025), 316 Stainless Steel (**500°F** - RK456 or **2000°F** - 7032), Ceramic (**2300°F** - 907GF) or Alumina (**3000°F** - 7020).
Just dispense and apply. These smooth, creamy putties will not run, drip or sag while applying and can be easily cured at room temperature.


## Surface Preparation

Surfaces should be free of oil, grease, dirt, corrosives or other contaminants.
Porous materials should be soaked in solvents to remove any soluble contaminants.
***For best results,*** roughen all smooth, metal surfaces with abrasives or grit blast them with a coarse media.

## Mixing

For one component systems: re-mix thoroughly before applying.
For two component systems: thoroughly re-mix the components before dispensing. Check label for mix ratios where applicable. Weigh out each component and thoroughly mix to a uniform consistency. The viscosity may be reduced by adding a small amount of thinner (5% by weight maximum) if required.

## Application

Putties may be applied using a spatula, putty knife or caulking gun. Multiple layers may be required for cross-sections larger than 1/8" to 1/4" to avoid blistering. Epoxy based systems can be applied in thicker sections without blistering.

## Curing

Individual cure cycles are specified on each product label. Below instructions are guidelines for curing. Alternative cure times may be appropriate for high volume production applications and should be tested in the specific application prior to use.
***Note: excessive fast drying (or applying high heat when moist) may cause blisters.***

**For ceramic based systems a typical cure schedule is shown below.**

1. Air dry for a minimum of 2 hours at room temperature. Thick cross-sections will require 4-16 hours to cure. Putties should be applied in layers carefully drying material in between coatings.
2. Heat cure at 150-200°F for 2 - 4 hours.
3. Post curing at 400°F is required for water insolubility.

**For epoxy based systems a typical cure schedule is shown below.**

1. Cure at room temperature for a minimum of 16 - 24 hours prior to use.
2. Post curing is recommended for optimum proprieties. For room temperature curing systems post cure for a minimum of 2 - 4 hours at 250°F. For heat curing systems post cure for 2-4 hours at 350°F.

## Storage

Tightly close opened containers after each use to prevent evaporation.
Periodically invert containers to help reduce settling.
Store containers between 40°F and 80°F.

**Safety** read MSDS carefully before use. Prolonged skin contact may cause irritation. Uncured materials can be washed from the skin with a mild soap and water. If any material contacts eyes, flush continuously with water and consult a physician immediately.

COTRONICS CORP.
www.cotronics.com (718) 788-5533 Fax (718) 788-5538

# Rescor Castable Ceramics

| Cat. No. | 740 | 750 | 760 | 770 | 780 | RTC-60 |
|---|---|---|---|---|---|---|
| **Description** | Insulating Foam | Shock Resistant | Ultra Temp. | Corrosion Resistance | General Purpose | High Purity |
| **Maximum Temp. °F** | 2300 | 2700 | 4000 | 2700 | 3000 | 3250 |
| **Base** | $Al_2O_3$-$SiO_2$ | $SiO_2$ | ZrO | SiC | $Al_2O_3$ | $Al_2O_3$ |
| **Standard Grades Sample Castings** |  |  |  |  |  |  |
| **Properties** | | | | | | |
| **Density** (# / $ft^3$)<br>($in^3$/10 # kit) | 54<br>223 | 110<br>157 | 250<br>69 | 145<br>119 | 180<br>96 | 175<br>98 |
| **Shrinkage** (% as cast)<br>(% @ 1000°F) | 0.50<br>1.00 | NIL<br>1.30 | NIL<br>1.00 | NIL<br>1.50 | NIL<br>1.00 | NIL<br>1.25 |
| **Compressive Strength** (psi) | 1,500 | 6,000 | 4,000 | 6,000 | 6,000 | 2,500 |
| **Modules of Rupture** (psi) | 900 | 1,500 | 1,200 | 1,500 | 1,800 | 1,000 |
| **Thermal Exp.** (x $10^{-6}$/ °F) | 4.5 | 0.3 | 5.6 | 4.5 | 4 | 4 |
| **Thermal Cond.** (BTU in/hr.°F $ft^2$) | 1 | 4 | 6.5 | 30 | 10 | 10 |
| **Dielectric Strength** (volts/mil) | 100 | 100 | N.A. | N.A. | 200 | 175 |
| **Volume Resistance** (ohm-cm) | $10^9$ | $10^9$ | N.A. | N.A. | $10^9$ | $10^{10}$ |
| **Moisture Resistance** | Excellent | Excellent | Excellent | Excellent | Excellent | Excellent |
| **Color** | Tan | White | Tan | Black | White | White |
| **Mix Ratio** (base/activator) | 100/64 | 100/28 | 100/18 | 100/24 | 100/24 | 100/10 |
| **Working Time** (minutes) | 20 | 20 | 20 | 20 | 20 | 25 |

*Manufactured in accordance with ISO9000*

# RESCOR™ CER-CAST CERAMIC

## Easy to use, Economical, Fast Setting and High Strength


Rescor™ Cer-Cast Castable Ceramics make Alumina, Silicon Carbide, Zirconium Oxide, Fused Silica and Insulating Ceramic Foam parts, tubes, crucibles, etc. in minutes. Rescor™ advanced ceramics are ideal for all your research, prototype and production applications.

### Trial Parts

*To check product shrinkage and strength prior to casting the desired part.*

Use a drinking cup with a 2" diameter. Pour the mixed material approximately 1" high. Follow the heat treating directions below. Check product shrinkage and strength and use values as a guide for creating the actual part.

***Note:*** *A thick paste like consistency will provide optimum strength and minimum shrinkage. A thick paste will flow when vibration is applied to the mold and container.*

### Estimating Shrinkage

Minor shrinkage normally occurs and must be taken into account for all critical applications. See below for typical shrinkage values. (Actual values will vary.)

| Cure Temp. | Typical Shrinkage (%) | Typical Strength (MOR) |
|---|---|---|
| Room Temp | 0.1 to 0.5 | 800 - 1200 psi |
| 1000°F (535°C) | 0.3 to 1.3 | 1000 - 2000 psi |
| 1700°F (910°C) | 1.0 to 2.0 | 3000 - 7000 psi |

### Molds

For best results use Replicast 101 Liquid Rubber or a urethane mold.
Before casting a part, apply a light coat of Spray on 101MR or brush on 102MR mold release.
It is not recommended to use metal molds. If metal molds are used, apply a thin coat of 102MR Paste Mold Release and design the mold with sufficient draft so that the cast ceramics can be removed.

### Ceramic Casting

*Check the product label for the mix ratio. All mix ratios are by weight.*

1. Weigh out the powder and the activator. Mix thoroughly, the material should become a thick, paste-like consistency. If casting parts with fine details add 1% or 2% extra activator, by weight. This will increase the fluidity of the mixture. Working time is approximately 10 to 15 minutes.
2. Pour the ceramic mixture into the mold and overfill it slightly. Work the slurry into the corners.
3. Vibrate the mold to remove air bubbles. (2-5 minutes should be sufficient.
4. After 20 minutes, remove any excess material with a trowel.

### Curing

1. Cover the mold with a thin sheet of plastic and cure for 16 - 24 hours at room temperature.
2. Heat the ceramic casting for 2 hours at 225°F (110°C). This will remove remaining water/ moisture and will create additional strength.
3. **For parts under 4" thick:** Heat the ceramic casting at a rate of 200°F per hour. Post cure at 1750°F (950°C) to increase the strength by 2 - 3 times.

**For castings over 4" thick:** request a special, slow curing instruction sheet (downloadable).

***Note:*** *Ceramic Castings will not out gas after they are fully cured.*

# Rescor Machinable Ceramics

| Cat. No. | 902 | 914 | 915 | 916 | 960 | 961 | 310M | 311 | 56L |
|---|---|---|---|---|---|---|---|---|---|
| **Material** | Alumina Silicate | Glass Based | MACOR™ | Boron Nitride | Alumina 96% | Alumina 98% | Silica | Alumina Silica | Graphite |
| Temperature Limit °F | 2100 | 1000 | 1800 | 1500 | 3000 | 3100 | 3000 | 2600 | 5400 |
| **Compressive Strength** (psi) | 38,000 | 40,000 | 50,000 | 30,000 | 60,000 | 380,000 | 1,200 | 500 | 16,000 |
| **Flexural Strength** (psi) | 14,000 | 26,000 | 15,000 | 10,000 | 38,000 | 40,500 | 520 | 250 | 6,500 |
| **Thermal Expansion** (x $10^{-6}$/ °F) | 1.8 | 5.2 | 5.2 | 5.24 | 4.3 | 3.7 | 0.3 | 2.9 | 3.1 |
| **Thermal Conductivity** (BTU in/hr.°Ft.$^2$) | 9 | 2.8 | 12 | 12 | 32 | 42 | 1.3 | 2.4 | 50+ |
| **Volume Resistivity** (ohm-cm) | $10^{14}$ | $10^{14}$ | $10^{14}$ | $10^{13}$ | $10^{14}$ | $10^{15}$ | $10^{9}$ | $10^{8}$ | N/A |
| **Dielectric Strength** (volts/mil) | 100 | 480 | 1000 | 1000 | 200 | 500 | 100 | 100 | N/A |
| **Loss Factor** (@ 1 Mhz) | 0.04 | 0.01 | 0.003 | 0.0008 | 0.0016 | 0.001 | 0.0002 | 0.02 | N/A |
| **Dielectric Constant** (@ 1 Mhz) | 5.3 | 7.5 | 6.0 | 4.4 | 9 | 9 | 3.17 | 2.17 | N/A |
| **Porosity** (%) | 2.9 | 0 | 0 | 2.0 | 10 | 0 | 63 | 52 | 10 |
| **Density** (gm/cc) | 2.30 | 2.60 | 2.52 | 2.00 | 3.0 | 3.82 | 0.80 | 0.80 | 1.63 |
| **Hardness** (Mohs scale) | 6 | 5 | 5 | 2 | 5 | 8 | 4 | 4 | 3 |
| **Adhesive for Bonding** | 919 | 940 | 940 | 908 | 989 | 989 | 940LE | 940LE | 931 |
| **Machining Instructions** (pg. no.) | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |

*Manufactured in accordance with ISO9000*

www.cotronics.com (718) 788-5533 Fax (718) 788-5538

# 902 PRECISION MACHINABLE CERAMIC

### Machining Tools

Use standard tools for turning, drilling, tapping, threading, milling, grinding, etc.
Use carbide tipped tools when available.
Keep tools sharp. Dull tools can cause chipping.
Use the cutting speeds and feed rates that are specified for metal machining.

***Do not use any lubricants or coolants.***

Clean machine thoroughly after machining. Rescor 902 particles are abrasive.

### Part Design

*Machine parts **1.8% to 2% undersized** to allow for expansion during firing.* A machined dimension of 0.980" will be 1.000" after firing. ***Diameters will expand from 1.8% to 2%.***

The cross sectional thickness of the ceramic should be kept below ½" to prevent cracking during firing.
Use a smooth, gentle transition from thick to thin sections and if necessary drill holes to keep the cross sectional thickness below ½".

### Firing

Place the machined 902 ceramic part into a cold, air atmosphere furnace.
Protect from any direct flame impingement or direct contact with heating elements.

### Heating Schedules

**For Parts ≤ 1/2" in Thickness**

Heat at 200°F (90°C) /hour until .....1900°F- 2000°F (1035°C - 1093°C)
Hold ¼" parts at temperature for .....½ hour
Hold ½" parts at temperature for .....1 hour
Furnace must be cooled to below 200°F (90°C) prior to removing the parts.

**For Parts ≥ 1/2" in Thickness**

Heat at 200°F (90°C) /hour until

| Set Point | Hold for a Minimum of |
|---|---|
| 925°F | 4 Hours |
| 1050°F | 4 Hours |
| 1550°F | 4 Hours |
| 1700°F | 4 Hours |
| 1950°F | 2 Hours |

Cool parts for a minimum of 4 Hours before removing.

**For Difficult Parts**

Heat at 50°F/hour until. . . . . 600°F
Followed by 35°F/hour between . . . . . 600°F to 1200°F
Followed by 15°F/hour until . . . . . 1950°F
Cool parts at a maximum rate of 200°F/hour.

***Note:** Fired 902 Ceramic can be ground wet with Silicon carbide wheels.*

### Trouble Shooting Guide

Before calling Cotronics' Technical Service

1. Check the furnace temperature and the curing schedule.
2. Check for full expansion.
3. Re-Design part with smooth, well rounded corners.

**Special Sizes, Quantity Prices, Custom Machined Parts Upon Request**

# MACHINABLE CERAMICS INSTRUCTIONS

## 310M - 914 - 960 - 915 - 56L

### Machining Tools

Use only sharp cutting tools, carbide cutting tools are preferred. Check tools for sharpness frequently. Ceramics can cause rapid wear of cutting edges. Clamp work firmly to avoid vibration and chatter.

### Lubrication

Keep a continuous stream of water on the work and tool. Insufficient lubrication will cause dulling of cutting tools and chipping of the ceramic. Lubrication is a must for precision work. Lubricants recommended include Cimstar 40 Pink, Supercut S67 and Quaker 103.

### Cutting

Use bonded silicon carbide or diamond cut off wheels with speeds of 6000 - 8000 S. F. M. (2000-2500 rpm). Cut down into work.

### Bandsaw

Use continuous coat, carbide grit blades. Use a band speed of 100 feet per minute.

### Drilling

Use Carbide drills, Carboloy 883 or equivalent. For high speed drills, drill slower. Never drill all the way through. Use a drill jig and drill from both sides.

***Re-sharpen bits every 3 - 4 holes.***

| Drill Size | RPM | Feed-RPI | Drill Size | RPM | Feed - RPI |
|---|---|---|---|---|---|
| 1/4 inch | 300 | 0.005 | 3/4 inch | 200 | 0.010 |
| 1/2 inch | 250 | 0.007 | 1 inch | 100 | 0.012 |

### Milling

| | |
|---|---|
| Cutting Speed (surface ft. per min.) | 20 - 35 |
| Chip Load (inches per tooth) | 0.002 |
| Depth of Cut (inches) | 0.150 - 0.200 |

### Threading

Use a diamond wheel with a tool post grinder or tungsten carbide tool.

### Tapping

Use high speed steel or carbide. Drill size should allow for 70% thread form. Use lubricant.

### Turning

Use carbide tool bits or silicon carbide wheels on post grinder.

| | |
|---|---|
| Tool Type | Carboloy 883 |
| Cutting Speed (surface ft. per min.) | 30 - 50 |
| Feed Rate (inches per revolution) | 0.002 - 0.005 |
| Depth of Cut (inches) | 0.150 - 0.250 |

### Grinding

Use a silicon carbide, resinoid bonded wheel at the recommended speeds.
**For Heavy grinding** use a soft, coarse grained wheel.
**For Finishing** use a hard, fine grained wheel.

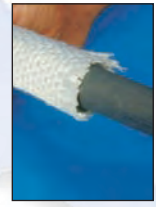
### *Note*

Heat treating ***is not*** required for use under 2400°F.
960 shrinkage may occur in use >2400°F.
Check for shrinkage before making actual parts by exposing a test piece to the service temperature for the intended usage time.

**Note:** *Cotronics' ceramics are abrasive. Clean machines thoroughly after machining.*

# Cotronics' Ceramic Paper, Blankets and Boards
# Sleeving, Rope & Moldable Putties






| CAT. NO.<br>DESCRIPTION | 300<br>Papers | 360<br>Boards | 360M<br>Moldable<br>Putty | 370<br>Flexible<br>Blankets | 372<br>Wrap-It<br>Sheets | Ultra<br>Temp.<br>Products | Tapes<br>Cloths<br>Sleeving |
|---|---|---|---|---|---|---|---|
| Melting Point ºF | 3200 | 3200 | 3200 | 3200 | 3200 | 3600 | 3000 |
| Continuous Use Temp. ºF | 2300 | 2300 | 2300 | 2300 | 3000 | 3000 | up to 2600 |
| Density (#/ $ft^3$) | 12 | 16 | 40 | 6-12 | 18 | 6-15 | 10-40 |
| Modules of Rupture (psi) | N.A. | 55 | 150 | N.A. | N.A. | N.A. | High Tear. |
| Dielectric Constant (@ $10^8$ cps) | 1.61 | 1.61 | 1.61 | 1.61 | 1.61 | 1.61 | 1.61 |
| Dielectric Strength (volts/mil) | 100 | 100 | 100 | 100 | 100 | 100 | 100-450 |
| Construction | Matted | Bonded | Putty | Matted | Wet Mat | Varies | Woven |
| Compressibility | Soft | Firm | Hard | Soft | Firm | Soft | Strong |
| Thermal Conductivity (*BTU/hr.ft.$^2$ ºF/ in.) | | | | | | | |
| 500ºF | 0.38 | 0.45 | 0.85 | 0.38 | 0.65 | 0.35 | 0.50 |
| 1000ºF | 0.60 | 0.70 | 0.90 | 0.60 | 0.70 | 0.55 | 1.00 |
| 1500ºF | 0.90 | 0.95 | 1.05 | 0.90 | 0.95 | 0.86 | 1.60 |

## Hints and Tips:

### Ceramic Paper and Boards

Contain a trace amount of organic binders which will discolor and give off a burnt odor when heating past 400ºF (204ºC) for the first time. Burn off will be complete after material is exposed to 600ºF - 800ºF (315ºC - 425ºC).
Ceramic boards can be hardened by applying, or soaking, in 901A ceramic hardener and then drying. Heating will increase the material's strength and hardness.

### Ceramic Putty and Wrap-it

These materials are water based. They cure by moisture evaporation. Material will be hard after the moisture completely evaporates. This is a slow process at room temperature that can be accelerated with mild heat (below 200ºF, 100ºC) and air flow.
Smooth Ceramic Putty with wet gloves and a putty knife. Keep wet to insure smooth surface.
Typically a 1/8" to 1/4" layer of Ceramic Putty or Wrap-It will dry in 48 hours at room temp.
A 1" thick layer may take up to 48-72 hours at room temperature.
Heating at 200ºF (100ºC) with mild air flow will reduce time to 4- 8 hours.

### Ceramic Cloths, Tapes and Sleeving

These materials may fray on cutting. Treat with a sealant before cutting to minimize fraying.
Call our technical sales representatives for recommendations.

### Replicast 101MR

Spray mold release can be used as a mold release for Ceramic Putty and Wrap-It.

***Materials also available in REACH compliant versions, call for details***

# PROTECTIVE COATINGS AND SEALANTS


Duralco™ Protective Coatings offer the ultimate in high temperature and corrosion resistance. Easy to use. Just select the proper grade for the application conditions and surfaces to be coated. Consult Cotronics' data sheets or our technical staff for assistance and recommendations.

### Surface Preparation

1. Remove old coatings, paints, greases, etc. Make sure the surfaces are free of grease, oil, dirt, old coatings, rust
2. Sand or grit blase blast surface using 100 - 200 mesh sand, alumina or iron grit.
3. Wash with Resbond 105RP Surface Prep Solvent.

### Mixing

Settling may occur due to high solids content.
For both one and two component systems: re-mix thoroughly prior to use.
*All ratios are by weight. See the product label for the exact mix ratio.*
For two component systems: Weigh out the base and activator into clean, separate mixing containers. Mix together thoroughly to insure a homogeneous mix.

### Application

Duralco coatings can be applied by brushing, spraying or dipping. Spraying is preferred for most for most applications as it will result in light moist coverage of the coating.
*To avoid runs and obtain smooth, uniform coverage* (when spraying) add up to 5% of solvent.
***Note:*** *a protective face mask must be employed to prevent inhalation of mist.*

### Coating Thickness

It is always preferable to apply the coatings in two thin layers rather than one heavy coat.
Allow parts to cool to room temperature then repeat above procedures to apply the second coat.
Make sure there is sufficient drying time between layers.
***Note:*** *Excessive fast drying, or applying high heat when moist, can cause blisters.*

### Drying

Follow instructions provided on the containers for each individual system.
Coatings should be fully dried before continuing with the final cure.

### Curing

Follow instructions on the individual product containers.
blisters. The coatings should be smooth and uniform. They should be free of all blisters when
***Note:*** *Excessively fast drying may cause blisters.*

### Post Cure

A post cure is required if the material is being used at temperatures below 250°F (120°C)
Follow the cure cycle as shown on the product label.

### Clean Up

Clean equipment with water or the required solvent.

### Toxicity

Precautions should be taken against inhalation, digestion, contact with eyes, open sores and cuts.
Consult the MSDS for specific recommendations.

***Note: a protective face mask must be employed to prevent inhalation of mist when spraying.***

### Mixing and Measuring Adhesives
Re-stir all products before weighing or dispensing. Carefully weigh out the resins and hardeners separately, before mixing. (Use a minium mix of at least 25 grams to insure a homogenous mixture) Mix thoroughly and completely before using. Improper measuring or mixing can cause materials not to cure, soft spots, air voids on the surface, sticky surfaces, softening at elevated temperatures, changes in chemical or electrical resistance.

### Bonding Dissimilar Materials
Select an adhesive with a thermal expansion coefficient that closely matches the materials to be bonded. When possible select a flexible epoxy. Clean dirt, oils, greases and mechanically roughen the surfaces prior to bonding. Cure materials at room temperature and at 250ºF.

### Recommended Bond Line Thickness For Adhesive Bonding
For standard epoxy and ceramic adhesives a bond line thickness of 5-8 mils (0.005-0.008) will produce excellent results. For Cotronics' non-sag putties (epoxy or ceramic) bonds of 0.020 or more can be used. To form a thick layer or section apply putty in several layers curing between each application.

### Joint Design and Bond Strength
Butt joints are usually the weakest, inserted joints ( tongue and groove, rod into a tube provide a mechanical reinforcing) are the strongest. For repair and difficult applications use a metal or ceramic cloth buried in the glue line for additional reinforcing.

### Bonding to Teflon, Nylon, Polyolefin and Similar Plastics
Specific surface treatments and/or etching are required for bonding these plastics. Cotronics' offers flexible and activated epoxies that form strong adhesive bonds to many of these difficult-to-bond materials.

### Preventing Flow of an Adhesive From a Joint
Select an adhesive with high viscosity or with thixotropic properties and use just enough adhesive to completely fill the gap between the two surfaces to be bonded.

### Thinning Adhesives for Application
Epoxy formulations can be thinned with mild heat or epoxy thinner 105RT to ease flow, create a thinner bond line or facilitate encapsulation.

### Removing Bubbles in Potting Materials
You can reduce the amount of entrapped air by warming epoxies prior to application or by vacuum degassing. (Apply pressure of 29 in Hg for 2 minutes and then release).

### Working With Electrically or Thermally Conductive Adhesives
Electrically and Thermally conductive adhesives will provide optimum results after a post cure for 2 hours at 250ºF. Electrically conductive materials are also available in flexible versions to accommodate bonding substrates with different thermal expansions.

### Cracking in Ceramic Adhesives and Castable Ceramics
Cracked and weak castings, encapsulations or adhesive bonds can occur when using ceramic materials if excess activator or additional water has been added to the uncured mixtures. Check the mix ratio that was used when mixing the materials.

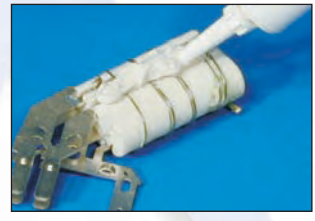
### Accelerating Cure Time
The best way to shorten the cure cycle is to raise the temperature. Typically most systems can be quickly cured at 250ºF. One should check each products data sheet or label for specific instructions and recommendations.

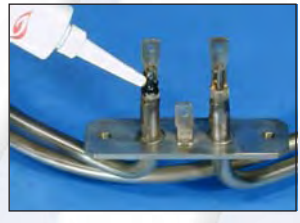
### Modifying Existing Formulations
Cotronics can adjust such formulations to provide variables as viscosity, gel time, curing characteristics as well as lap shear strength, peel strength, flexibility, chemical stability, heat resistance, impact strength color etc.

### Special Packaging for Production Applications
Cotronics can supply materials in pre-measured units and in bulk quantities to facilitate the use of these systems in any production facility or field application.

# HIGH TEMP. MATERIALS
# INSTRUCTIONAL HANDBOOK









***For Specific Application Assistance***
***Contact Cotronics' Application Engineers 718-788-5533***

***For Additional Technical Visit Our Website***
***www.cotronics.com***