SOLDERING TO NITINOL

Nitinol (nickel/titanium alloy) has increasingly become a very popular material in the medical industry, largely due to its shape memory characteristics, where it is often used in stents, catheters and other implants. Medical device manufacturers often wish to mechanically bond Nitinol to another metallic material, such as stainless steel, using a solder alloy.

The key to soldering to Nitinol is using an appropriate flux that will effectively reduce both the nickel and titanium surface oxides. Since the devices are used in the human body, it is important that the selected solder alloy has minimum biological activity and the flux residue is completely removed after the soldering operation. Therefore, it is imperative that the selected solder alloy contains no high toxicity metals such as lead, antimony or cadmium.

The tin-silver eutectic solder, 96.5% tin, 3.5% silver (Indalloy #121), is a preferred alloy in that the tensile strength of this solder is high, has a reasonable melting temperature of 221°C, is lead-free, and wets well to Nitinol. The gold-tin eutectic solder, 80% gold, 20% tin, (Indalloy #182), has even higher tensile strength along with a good resistance to peel and with a melting temperature of 280°C can withstand autoclaving temperatures. In using this alloy a nitrogen protective cover gas gave more consistent results and simplified flux removal. The high gold content is also very acceptable for in vivo applications. Although these solder alloys have lower toxicity than common tin-lead solder, it is imperative that the medical manufacturer conduct the necessary tests to insure that the constituents will have no adverse health effects when used in a particular application within the human body.

In wettability tests, it was found that Indalloy Flux #2 provides the best wettability to Nitinol. Soldering temperature should be 25° to 50°C above the liquidus temperature of the solder. Adequate post soldering cleaning of the flux residue using detergent, water and mechanical scrubbing should be performed to insure that all traces of the flux are removed. Appropriate testing should be done to insure that all traces of the flux have been removed.

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## MECHANICAL PROPERTIES

| Indalloy Number | Liquidus °C | Solidus °C | Density gm/cm³ | % of IACS | Electrical Conductivity µohms-cm⁻¹ | Thermal Conductivity W/cm⁻¹ °C | Thermal Expansion PPM °C | Tensile Strength PSI | Shear Strength PSI | Young's Modulus PSI | Elongation % | Brinell Hardness | Latent Heat of Fusion J/g | Specific Heat C/°C | Specific Heat C/°C | Indalloy Number |
|----------------|-------------|------------|----------------|-----------|-----------------------------------|-----------------------------|-------------------------|----------------------|-------------------|------------------|--------------|----------------|----------------|----------------------|----------------|-----------------------|---------------------|
| 121            | 221         | 221        | 0.2659         | 7.36      | 16                                 | 33                          | 30                      | 5620                 | 73                | 40               |              |                | 430                        | 430                      |                      | 121                 |

Lead free high temp solder. Excellent thermal fatigue properties. Not recommended for soldering to gold thicker than 0.5 microns.

### NOTES

- **note 1:** Brinell Hardness, 2mm ball, 4kg load
- **note 2:** Modified Brinell hardness, using 100-kg load, 1/2 min.
- **note 3:** Depends on specimen preparation.
- **note 4:** % elongation on 5.65 (sq. root Area) gauge length

### Conversions:

- Resistivity of IACS / Elec. conductivity %IACS = Resistivity of alloy
- ex: 1.72 x 100 / % IACS = micro ohm - cm