S-Bond Technologies, LLC	S-Bond® Joining of Sapphire & Ceramics to Metals	Technical Bulletin Bulletin No. SBT-SC-001 (RevA)

S-Bond® active solders enable the joining of ceramics and sapphire to each other and to metals. S-Bond alloys have active elements such as titanium and cerium added to Sn-Ag, Sn-In-Ag, and Sn-Bi alloys to create a solder that can be reacted directly with the ceramic and sapphire surfaces prior to bonding. S-Bond alloys produce reliable, hermetic joints with all metals…including steel, stainless steels, titanium, nickel alloys, copper and aluminum alloys…

- Directly without the use flux.
- Without pre-plating steps, eliminating multiple step coating processes.
- At temperatures below 400ºC, preventing distortion and softening of metals and preventing ceramic fracture.

The joints produced are:

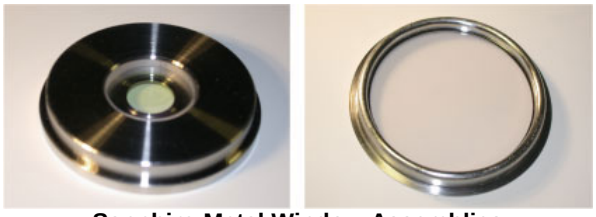
- Hermetic, passing < 10^{-9} atm-cc/ sec
- Strong (> 5,000 psi shear)
- Ductile, based on Sn-Ag or Sn-In alloys

Processing

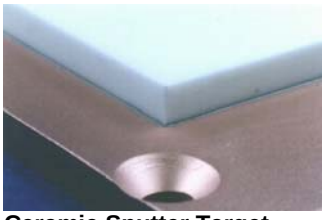
Two Different processes can be used to make joints. One method is the "mechanically activated" joining at near the S-Bond melting temperature, (e.g. for S-Bond 220, that is 250ºC). This is done by spreading, rubbing, or brushing the molten alloys onto heated surfaces and assembling "hot" in a way that the S-Bond alloy surfaces are agitated sufficiently to break the thin oxide skins that form while molten. Such joints on ceramics and many metals are adhesive, but have no chemical bond. An example of the bond is shown, bottom right. S-Bond alloys do bond, but the joint strengths are nominally below 3,000 psi in shear. The figure to the right illustrates the adhesive nature of the bond

Another S-Bond joining process is thermally activated using a proprietary process, which prepares the ceramic and sapphire surfaces and develops a chemical bond to the surface, through reactions of the active elements in S-Bond alloy. These joints start with an elevated temperature treatment in a protective atmosphere furnace with S-Bond alloy placed on the ceramic surfaces to be joined. At the elevated temperatures, the active elements in S-Bond react with the ceramic to develop a chemical bond, as shown in the figure directly to the right. This chemical bond and the S-Bond layer in a subsequent joining step provides a much higher level of joint strength and creates high performance ceramic-metal joints that are better than most brazed sapphire and ceramic to metal joints made by the multi-step Mo-Mn and plating processes.

Examples of Sapphire and Ceramic Metal Components



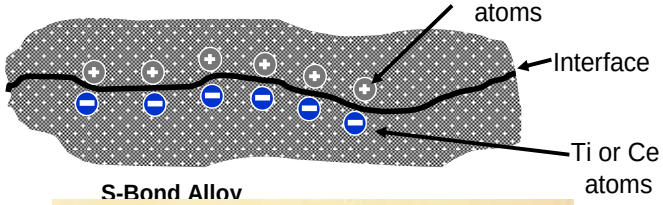
Sapphire-Metal Window Assemblies

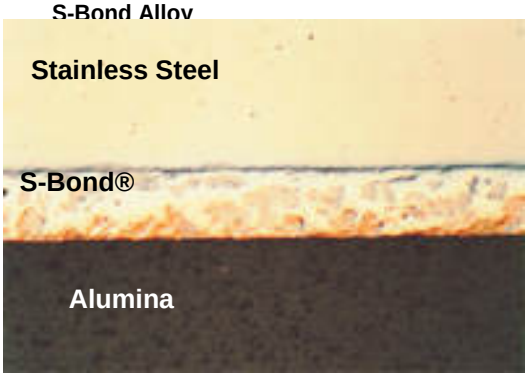


Ceramic Sputter Target

Detector Housing- Sapphire to Ti

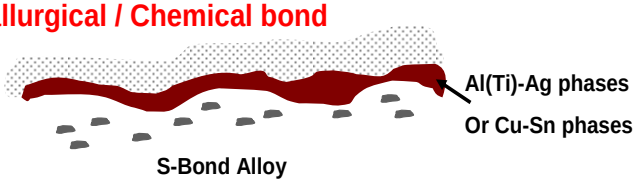
Adhesive Bond





Stainless Steel - Alumina Joint Adhesive Bond

Metallurgical / Chemical bond



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The microstructure shown in the figure to the right illustrates that a chemical bond has been created between the alumina (Al_2O_3) and the S-Bond interface.

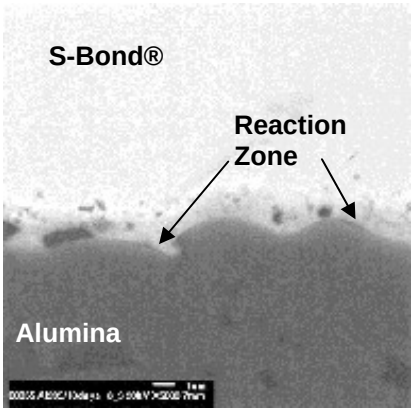
S-Bond joint shear strengths, using the elevated temperature S-Bond metallization procedure exceed 7,000 psi and are resistant to thermal cycling from -50 – 150ºC.

S-Bond joins sapphire, ceramic and metal surfaces without flux or plating and the process is much more tolerant of joint variations due to the nature of the S-Bond alloys' high surface tension. S-Bond joining does not use chemical fluxes that must be cleaned up or could etch metallic components, leaving cosmetic defects.

S-Bond joining:
- Is a single step process.
- Eliminates multiple- step metallization.
- Lowers joining temperatures compared to conventional active brazing.
- Permits larger and more complex assemblies to be fabricated without sapphire/ceramic cracking.
- Does not require plating of sapphire or the metal in the assemblies.
- Increases process yields related to joint failures from poor metallization layers.
- Lowers joining costs with reduced steps
- Eliminates clean up of flux residue
- Produces a reworkable joint that can be taken apart and reliably joined again
- Can repair sapphire-metal seals

Components include:

- Sensor Housings
- Detectors
- Optics
- Laser Windows
- Wear Surfaces
- Sensor Devices
- Piezoelectrics
- Tranducers
- MEMS enclosures
- Spectroscopic Windows
- Electronic Packages



Alumina to S-Bond Interface

S-Bond joining meets the needs of many applications where sapphire and/or other ceramics need to be joined to metals. The figure below illustrates other applications of S-Bond joining. Thermal management and heat sinks, C:C composites to aluminum, Si-die attach, quartz to brass sensor housings, MEMS sensors on BeO to brass and foamed metals.

S-Bond® joining typically results in:
- Yield Improvement
- Better Quality
- On-time Delivery
- Fewer Process Steps
- Reduced Costs
- Reparability

So contact us for an assessment if your joining requirements can be met with S-Bond.

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