

Autoclavable Force and Pressure Sensors

From medical robotics to handheld tools, healthcare today is using smarter surgical tools that give force and pressure feedback. Smart surgical tools can help in many applications such as haptic feedback for minimally invasive surgery using robotics or handheld instruments, pressure sensing for catheter tip steering and ablation, torque sensing of rotary tools, and more. These high value instruments are too expensive for single use and require autoclave sterilization for reuse. Until now, autoclavable sensors require complex, expensive packaging to ensure survivability and reliability.

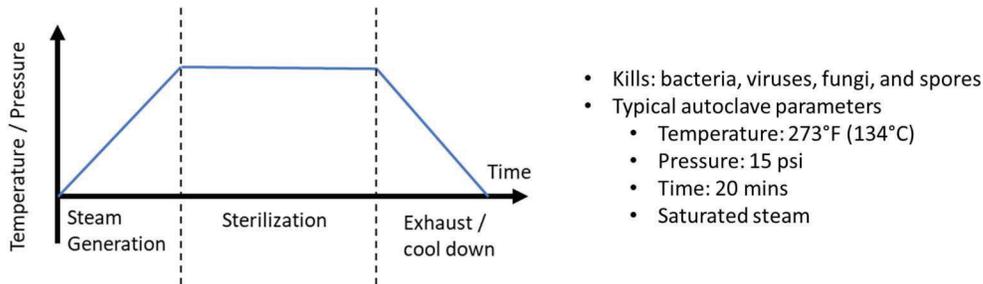


Figure 1 Schematic of a typical autoclave cycle.

Autoclave is a high temperature and pressure, steam sterilization process that may also include detergents. A typical process consists of a 20-minute soak with saturated steam at 134°C and 15 psi. This sterilization cycle kills bacteria, viruses, and fungi to not infect the next patient. Autoclave also attacks sensitive strain gauges the organics used to bond traditional strain gauges to a substrate. This can result in dramatic zero balance and span instability. Industry focus on this issue has been on how to better protect the strain gauge from this harsh environment. A natural solution to this is using glass-to-metal headers and a welded hermetic body. However, this solution is complex, expensive, and inflexible – holding back creative solutions to immersing smart surgical tools.

Strain Measurement Devices, Inc. uses a high energy thin film sputter deposition process to bond strain gauges to a substrate without the use of organics. Because this is a batch-controlled process, we can reliably and repeatably produce sensitive and stable force sensors efficiently – ultimately lowering production costs when compared to bonding individual strain gauges, and without compromising performance.

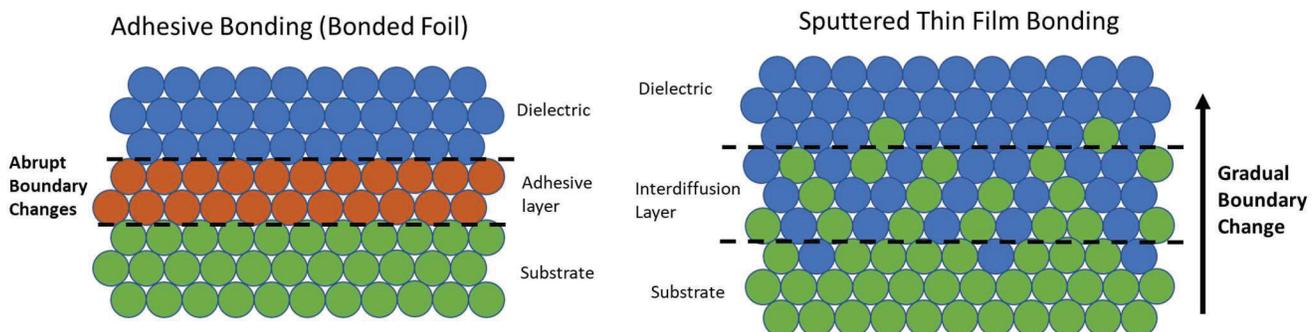


Figure 2 Atomic scale comparison of bonding characteristics between bonded foil and thin film strain gauges. Due to lack of adhesive and abrupt boundary changes between layers, thin film strain gauges are no prone to adhesive and cohesive failures or swelling from high humidity.

To address industry demands for an autoclavable force sensor, we took our thin film process to the next level by sputtering a protective encapsulation and enabling soldering directly to thin film. We can produce the same underlying reliable strain gauge, but with autoclave survivability inherently built in and no organic interlayer – reliability from the bottom up. This patented “case hardened” autoclavable strain has been field tested for 10 years and hundreds of autoclave cycles. It is not limited by packaging or next assembly constraints and can be applied to any of our standard force and pressure sensors as well as OEM sensors with specific requirements.

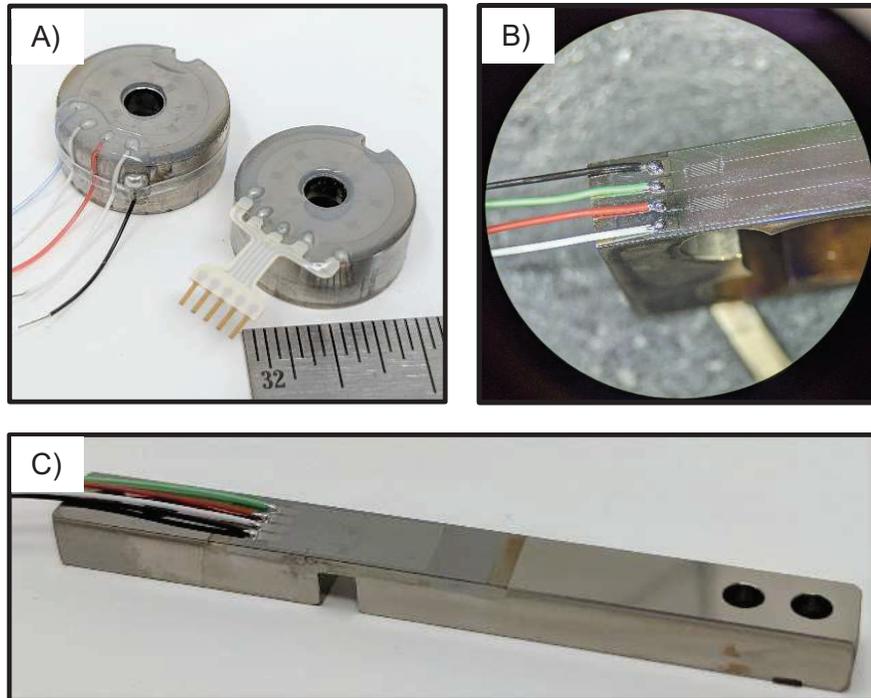


Figure 3 A) Autoclavable force sensor. B) Autoclavable S251 and close up of direct solder pads. C) Autoclavable S100