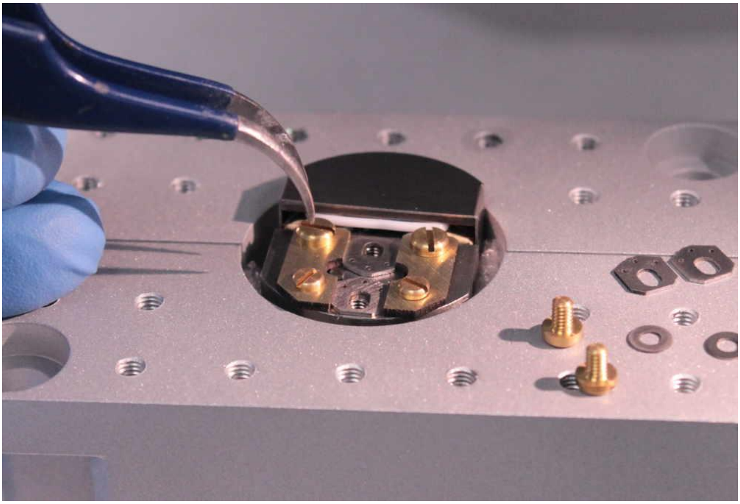


# AP005: MOUNTING SAMPLES

This document describes a practical procedure for mounting samples for the application of stress and strain at cryogenic temperature.

The Razorbill instruments stress and strain cells are versatile tools for applying uniaxial stress and strain at low-temperature. Because scientific experiments are necessarily involve doing procedures that have not been done before, many materials and or probes will require the development of new mounting procedures or the use of the cell in even more unconventional ways. Consequently, this application note should be considered only a starting off point for how samples may be mounted and not a complete account.

## MOUNTING PROCEDURE

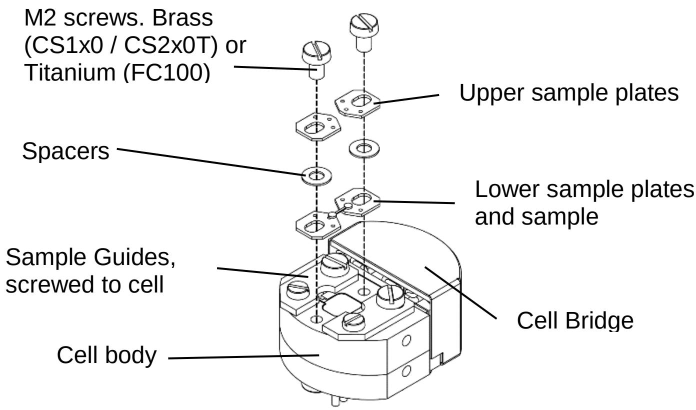



**Figure 1: Exploded diagram of CS100 sample mounting**

The overall procedure for mounting a sample of the CS1X0, CS2x0T and FC100 cells is similar and this guide covers all products (although the pictures used illustrate the process mainly show a CS100 cell).

The aim of the sample mounting process is to affix a sample (typically a matchstick shaped piece of ceramic, 1–2 mm long) so that it experiences homogenous uniaxial stresses and strains when the device is operated. It should be electrically isolated from the cell and the middle of the sample should be clear of epoxy and hence available for probing using *eg.* Electrical contacts or a scanning probe tip.

To achieve this, the sample must be held firmly as both ends by epoxy. The sample ends should be completely surrounded by epoxy at both ends (not in contact with the sample plates) so that the are electrically isolated, and so that the stress is applied evenly to the sample (not just to the bottom of the sample). The gap between the sample plates should be as large as possible while being small enough for the sample to straddle it with enough overlap for each end of the sample to be held firmly by the epoxy. The sample plates and the sample should be aligned with the direction of strain.

The following guide briefly describes one possible procedure for achieving this and offers some hints to overcome common problems.

## 1. Securing the strain cell and affixing the sample plate guide

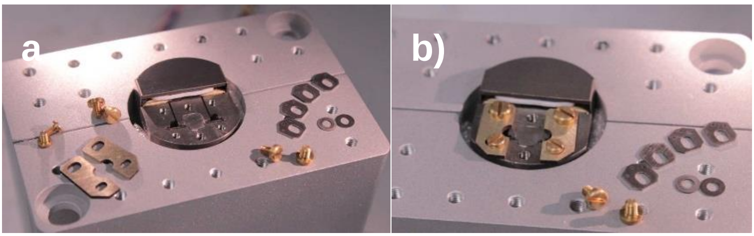



**Figure 2. a) To secure the CS100 strain cell in place, clamp the main body, not the bridge. b) With the sample plate guide installed.**

While the sample is mounted it is recommended that the stress or strain cell is secured in place.

### CS1X0 Strain cells

The strain cell body may be clamped or secured in a specially designed stand as shown in the photographs. The bridge must not be clamped, as doing so may damage the piezoelectric stacks.

CS1x0 cells manufactured before August 2019 use a single u shaped sample plate guide, whereas later models, and all CS2x0T cells ship with a two-part sample guide which allows the gap to be precisely adjusted. Either way, the procedure is similar. The sample plate guide is affixed to the top surface using one M2 and one M1.6 (CS1x0) or two M2 (CS2x0T) screws for each half. The guide is intended to simplify aligning the sample plates in the following sample mounting steps.

### FC100

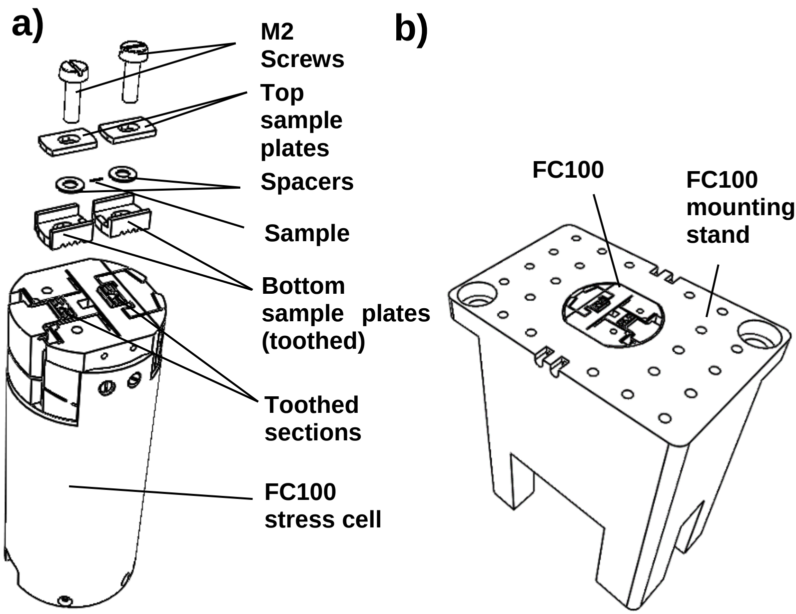



**Figure 3. a) The FC100 cell with its sample plates and spacers labelled. b) the FC100 is provided with mounting stand so that it can be held in position during sample mounting. This stand can be fitted into a mounting table for extra control during sample mounting.**

The FC100 is provided with a mounting stand in the *Sample Mounting Kit*. Retrieve this stand and insert the cell as shown. The FC100 has no need for the sample plate guide as the teeth on the bottom of the bottom sample plate mesh with the teeth on the top surface of the FC100 and keep the sample plates well aligned with the direction of applied strain as the bolts are done up (see section 4).

## 2. Adding bottom sample plates

### CS1X0 Strain cells

In this mounting procedure, each end of the sample is secured with lower and upper sample plates, separated by spacers. Place the lower plates as illustrated. The gap between them can be adjusted to suit the sample, ensuring there is enough overlap with each end of the sample to hold it securely.

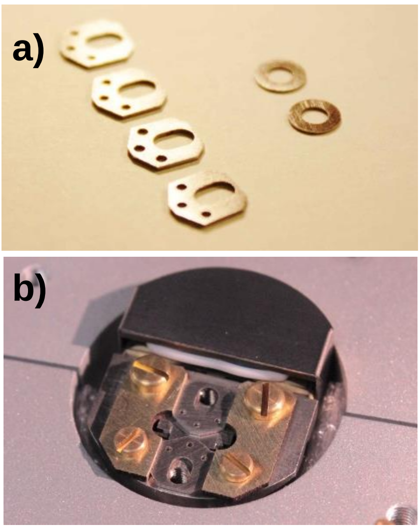



**Figure 4.**

**a) The sample plates and spacers required for the mounting procedure (CS100 plates pictured).**

**b) The bottom sample plates laid in the correct position.**

### FC100

It should be noted that because of the way the teeth of the FC100 sample plates mesh with the teeth on the top surface of the cell, the spacing between the plates is discrete rather than continuous as in the CS1X0. The gap may be adjusted by 1 mm by moving the plates one tooth together or apart and by 333 um by turning the plate end-to-end. By rotating both plates and moving them over the teeth, the gap may be adjusted in 333 um increments from 200 um to 2.8 mm. At this stage you will need adjust the gap spacing so that it is suitable for your sample, the sample should be able to straddle the gap resting on each side, but as much as possible of the sample should be exposed between the plates.

The rest of the mounting procedure may be easier if the lower sample plates are lightly secured with, e.g., GE Varnish.

## 3. Adding spacers and attaching the sample

One common problem encountered by our customers is that the sample makes electrical contact with the sample plate through the epoxy, disrupting electrical measurements being performed during the experiment. To prevent this, epoxy thickness spacers (such as silica beads, cotton fibres, cigarette paper or tissue paper) can be added or placed in the epoxy above and below the sample to set the glue thickness. These should be used in addition to, not in place of, the sample plate spacer. Alternatively, a thin layer of the epoxy can be painted onto the tip of the sample plates where the sample will be laid. This thin epoxy layer can be fully or partially cured before the sample (and additional epoxy) is added. This bottom cured layer ensures the sample does not sink through the epoxy to make contact with the bottom sample plate.

For attaching the sample, we recommend using a two-part epoxy such as stycast 2850. Firstly, decide on a suitable approximate epoxy thickness: if the epoxy is thicker, the maximum shear stress within the epoxy is lower, and the sample and epoxy are less likely to fail at high applied strains. If the epoxy is thinner, strain is applied to the sample more efficiently, and higher strains are possible in principle. An epoxy thickness of 30–50 µm is a good place to start.

Sand the spacers down to match the thickness of the sample, plus desired epoxy thickness. E.g. if the sample is 100 µm thick and ~30 µm-thick epoxy layers are desired, sand the spacers down to 160 µm thick. If using epoxy thickness spacers be careful that the sample will not be crushed when the upper sample plate is installed. E.g. if the sample is 100 µm thick and 25 µm epoxy spacers are used, the sample plate spacers might be sanded to 170 µm in thickness, leaving 20 µm margin

Sand the spacers in a way that their upper and lower surfaces remain parallel.

In Fig. 5(a), epoxy spots (white) and epoxy thickness spacers have been laid in the uncured epoxy. The thickness spacers here are 30 µm diameter nylon fibre (too narrow to be visible in the photographs), intended to set the epoxy thickness to ≥ 30 µm.

In Fig. 5(b), the sample has been placed on the epoxy. If desired, the ends of the sample may protrude over the central holes in the lower sample plate: by doing so the ends of the sample will be accessible for contacts for electrical transport measurements.

In Fig. 5(c), epoxy has been placed on the upper surface of the sample. Further fibres as epoxy thickness spacers have again been added.

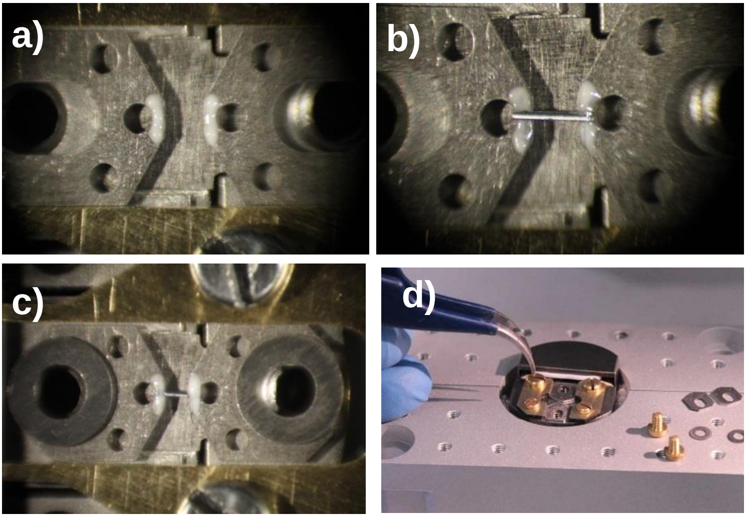



**Figure 5. a) The spacer disks are laid on top of the of bottom sample plates above the tapped holes. Close to the tips of the triangular end of the sample plates, a small daub of epoxy is deposited with a single fibre brush. Onto these droplets are added 30 µm diameter fibres. b) Additional epoxy is added and the sample is laid so it straddles the two plates. c) Additional epoxy is added and an additional pieces of spacer fibre are added on top of the sample. d) These very precise motions are carried out under a stereomicroscope with high quality tweezers.**

### 4. Adding the top plate and bolts and removing the sample plate guide

Place the upper sample plates on top of the sample and epoxy. Insert and tighten the M2 sample plate screws and then cure the epoxy.

When curing the epoxy, observe the maximum permitted temperature on the cell datasheet, excessive temperature will damage the piezoelectric stacks or the electrical insulation. If using a high temperature cure connect all four drive wires together, (preferably through resistors) to prevent large voltages building up on the piezoelectric stacks.

It is also possible to "pre-compress" or "pre-tension" the sample at this stage. Up to a maximum of ± 15 volts can be applied to the stacks to pull the sample mount points together or apart as the epoxy is curing; when the voltage is released the sample will be tensioned or compressed as desired.

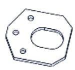
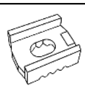
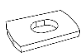
## Mounting Plates and Spacers

All the below sample plates and spacers are available from Razorbill Instruments. Asterisked entries are provided as standard with the purchase of the relevant stress/strain cells. The others are available on request. This list is updated from time to time, download the most recent version of this note to see new options.

If you would like an option which is not listed for your particular cell, or if you have an idea for an alternative sample mounting technique please get in touch. Razorbill Instruments will be happy to advise you and/or make suitable sample mounting hardware for you.

All the following items are manufactured from titanium.

Please note: compatibility with CS1X0 denotes compatibility with CS100, CS110, CS120 and CS130 strain cells. Similarly, CS2X0T covers CS200T and CS220T.

| **Name** | **Part Number** | **Diagram** | **Compatibility** | **Description** |
|---|---|---|---|---|
| Standard CS1X0 sample plates* | CS100_smplplts |  | CS1X0 | Top and bottom sample plates for CS1X0 cells |
| Bottom FC100 sample plates* | FC100_SmpPlt |  | FC100 | Toothed, bottom sample plate for FC100 cells. |
| Top FC100 sample plate* | FC100_SmpCov |  | FC100 | Top sample plate (cover) for the FC100. |

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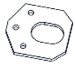
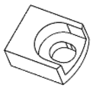
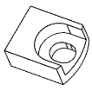
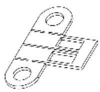
|---|---|---|---|---|
| Standard CS2x0T sample plates* | CS200_smplplts |  | CS2X0T | Top and bottom sample plates for CS2X0T cells |
| Standard spacer* | CS100_spcr |  | FC100 CS1X0 CS2X0T | Spacer that sets the distance between the top and bottom plates. Should be sanded to an appropriate thickness. Initial thickness 250 um. |
| Narrow spacer | CS100_spcrN |  | FC100 CS1X0 CS2X0T | Narrower version of above. Initial thickness 50 um. |
| Horizontal mounting spacer | CS100_spcrH |  | CS1X0 | Can be used instead of a spacer to hold a sample horizontally for transmission mode probes |
| CS1X0 wide angle sample plates | CS100_widanplts |  | CS1X0 | Bottom sample plates that raise the sample up so that it is the highest point on the top of the CS1X0 cell and hence allows 360° probe access to the sample |
| FC100 wide angle sample plates | FC100_widanplts |  | FC100 | Same as above for the FC100 |
| CS1X0 small/ 2D sample plates | CS100_smplplts_ 2D |  | CS1X0 | Sample plates held at a 200 um spacing via flexures for small samples and 2D materials |