Application Note

Almax easyLab introduces the ChicagoDAC for Low Temperature measurements at High Pressure

Almax easyLab developed the ChicagoDAC cell in collaboration with Prof. Rosenbaum group then at Chicago, now at Caltech (USA). It is dedicated to transport measurement at high pressure in Quantum Design's PPMS® equipment. It can also be fitted with a patterned anvil a very convenient way to measure sample transport properties. By using compact bellows in this design, it allows the user to tune the pressure inside the cell while at low temperature. Also, the use of focusing lenses and optical fibre in the design provides in situ pressure monitoring by measuring ruby fluorescence. Figure 1a shows an exploded view of the ChicagoDAC constituting parts and Figure 1b shows the cell fully assembled.

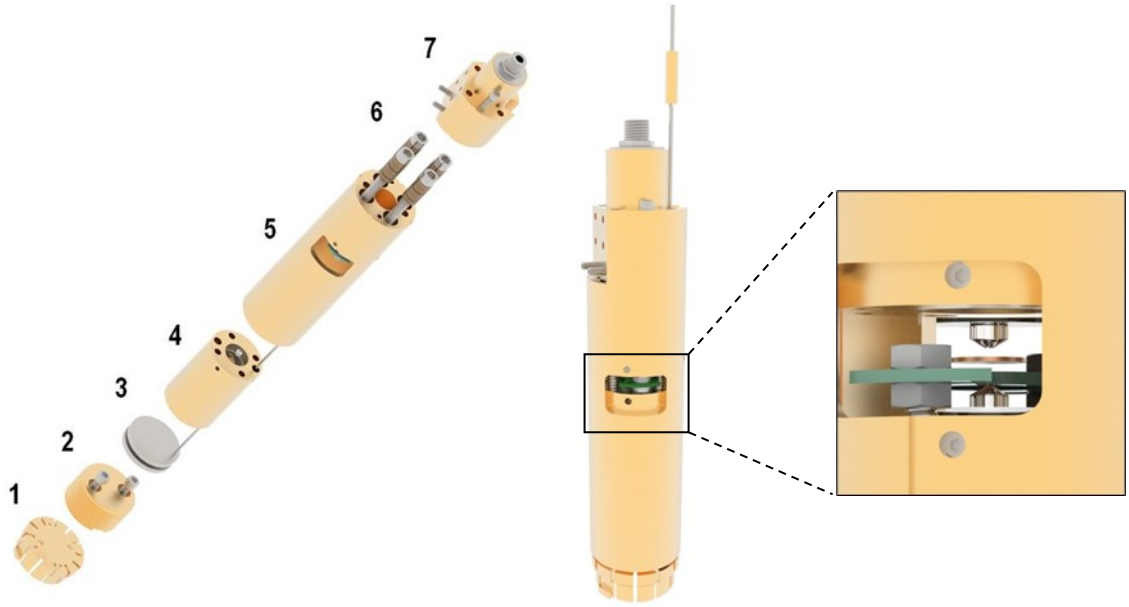
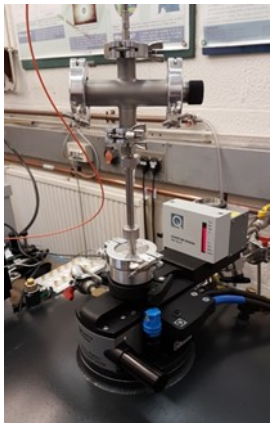
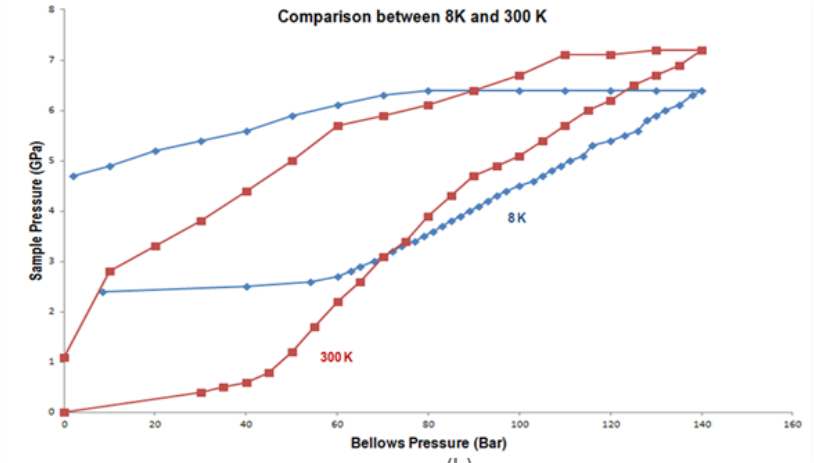


Figure 1: (a) Exploded view of the ChicagoDAC constituting parts, (1) PPMS sample puck, (2) Plug for bellow confinement, (3) Bellows actuator, (4) Piston mounted with a sapphire seat and a diamond anvil, (5) Cell body or cylinder, mounted with a sapphire seat, a diamond anvil, a gasket and a PCB for electrical connections, (6) Four screws with stacks of spring washers for sealing, (7) Optics mount containing fiber coupler and two plano-convex lenses. (b) The ChicagoDAC parts described in (a) are fully assembled. (c) Zoom in through one side window: the two sapphire seats and the two mounted anvils can be observed with the gasket and the fixed PCB.

The ChicagoDAC has been tested mechanically at 300 K and down to 8 K, using diamond anvils with 0.80 mm culet. A BeCu gasket (5 mm diameter, 300 micron thick) was pre indented to 2000 N using a hydraulic ram. The pre indented gasket thickness was then 120 micron. A 250 micron hole was drilled with our Boehler microDriller EDM machine. The sample chamber was loaded with ruby spheres and silicon grease. The four screws with spring washers were tightened in order to close and seal the ChicagoDAC. The cell was mounted onto the insert (optional) compatible with PPMS equipment, and ruby fluorescence could be measured using an optical fibre. The sample pressure was increased up to 7 GPa using the bellows (140 bar gas pressure) and then decreased back to ambient pressure. Figure 2a shows the insert mounted onto a Quantum Design's PPMS® cryogenic station. The results of compression and decompression runs at 300 K and 8 K using the hardened BeCu gasket are presented in Figure 2b.



(a)



(b)

Figure 2: (a) The ChicagoDAC and insert mounted onto Quantum Design's PPMS® cryogenic station for high pressure test at 8 K. (b) Sample pressure (GPa) according to gas pressure in the bellows (Bar) during compression and decompression run using hardened BeCu gasket at 300 K (in red color) and 8 K (in blue color).

All hardware in this experiment was controlled by High Pressure Manager (HPM) software which allows a convenient in situ tuning of the sample pressure and the membrane pressure. Indeed, the Optiprexx PLS connected to the ChicagoDAC with an optical fibre for Ruby fluorescence pressure measurements and the iGM controller which tunes the membrane pressure, were coupled together and monitored directly from the HPM software interface (see Figure 3).

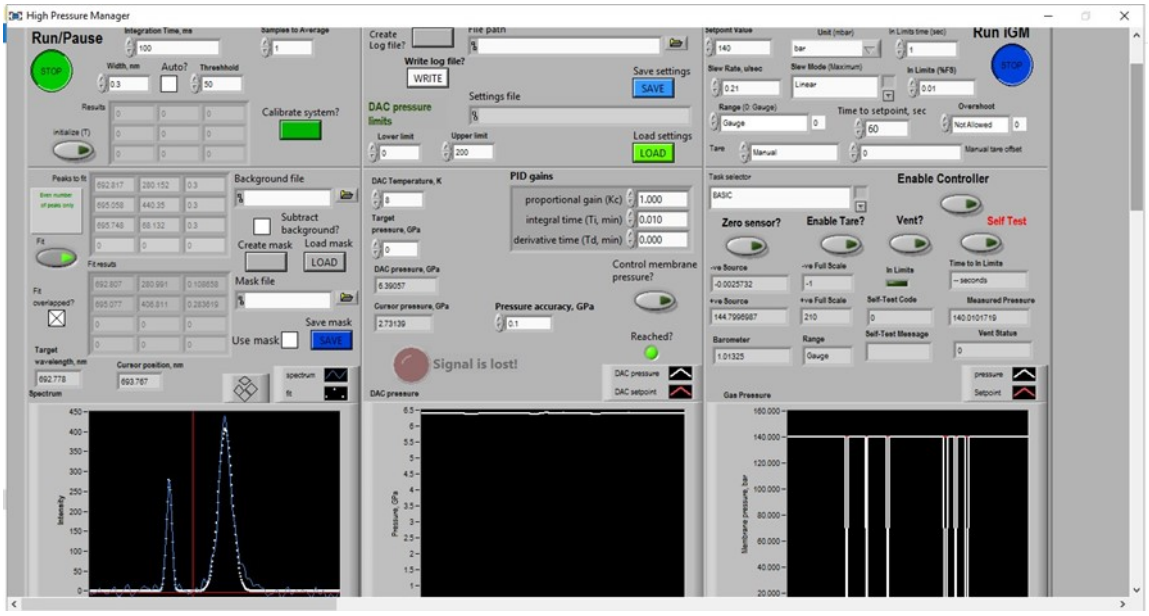


Figure 3: HPM software interface: an example of the interface showing here the Ruby measurement at 6.4 GPa and 8 K (140 bar in the membrane) on the left panel. The iGM control panel is shown on the right.