Installation of diamond window in Paris-Edinburgh press for sample analysis before, during, and after ion irradiation *

Michael Burchard[1], Ulrich A. Glasmacher[1#], Sebastian Dedera[1], Christina Trautmann[2,3]

[1]Institute of Earth Sciences, University of Heidelberg, [2]GSI Darmstadt, [3]Technische Universität Darmstadt

To investigate matter under extreme conditions, materials have been simultaneously exposed to pressure and ion irradiation. Most experiments have been performed by pressurizing miniature samples (<0.001 mm^3) in diamond anvil cells (DAC). Larger samples (up to 1 mm^3) can be pressurized in a Paris-Edinburgh (PE) press where the sample in placed between two hard anvils made, e.g., from cubic boron nitride, allowing quasi-hydrostatic compression up to ~ 10 GPa.

In the recent past, we successfully tested our PE press as a tool to expose large-volume samples under pressure to energetic heavy ions in Cave A [1]. To perform spectroscopic investigations of the sample under pressure (advantage of diamond anvil cells), the PE cell anvil was equipped with a diamond stamp in beam direction [1, 2]). This new diamond window (Fig. 1) provides access to a laser beam in order to perform "in situ" Raman spectroscopy measurements of pressurized samples (Fig. 2). Besides many handling advantages, the modification also allows us to determine the real pressure inside the PE-cell by means of Raman line shifts (Fig. 3).

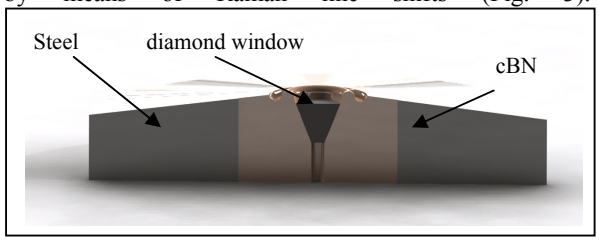

Figure 1: Cross section of pressure stamp of PE-cell with the new diamond window.

For the first test irradiation of the new setup in August 2012 we mounted a calcite crystal ($CaCO_3$) and pressurized it to 0.9 GPa. Calcite is quite suitable for this test, because it has well defined Raman bands. The irradiation was performed in cave A at the SIS18 using a focused beam of U ions of 250 MeV/n initial energy. A total fluence of 1×10^{11} ions/cm^2 was applied.

The mounting and positioning of the PE cell with the overhead gantry resulted in no further problem. The deactivation time of the irradiated PE cell was remarkably short. Most of the activation disappeared two days after the irradiation. After two weeks, the cell could be handled safely.

The new setup of the Paris Edinburgh cell provides many new possibilities for "in situ" measurements of irradiated samples under pressure, although some design details are still on a preliminary status.

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ulrich.a.glasmacher@geow.uni-heidelberg.de

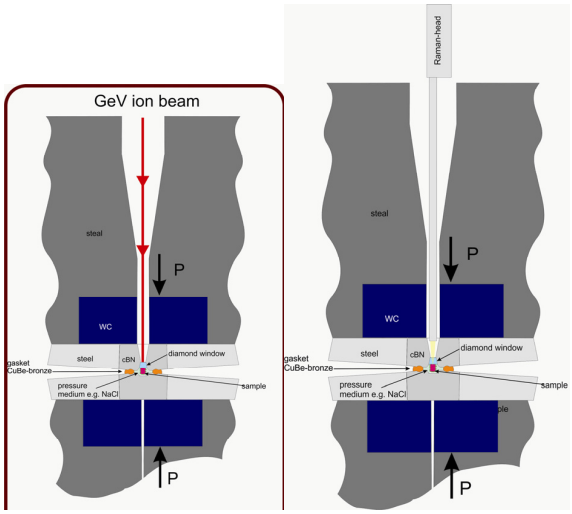

Figure 2: Cross section of new PE-cell design, (left) under ion irradiation and (right) for spectroscopic analysis.

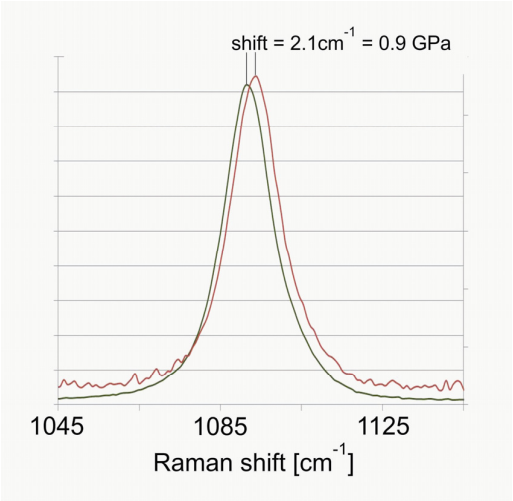

Figure 3: Raman spectra of calcite recorded through the new diamond window of the PE cell at ambient pressure (smooth black line and in pressurized state (red line).

References

[1] M. Burchard et al. "Ion irradiation under pressure using the Paris-Edinburgh press: first results", GSI Scientific Report 2009, p. 345

[2] A New Design for Diamond Window Equipped Paris-Edinburgh-Calls - First Tests and Results, Eos Trans AGU Fall Meet Suppl., Abstract MR23A-2390: