ESRF	**Experiment title:** Microtomography analysis of microvoids in metals. Correlation with ductile fracture mechanisms.	**Experiment number**: ME-208
Beamline: ID15	**Date of experiment**: from: 29 april 2001 to: 4 may 2001	**Date of report**: 30/08/02
Shifts: 12	**Local contact(s)**: Marco Di Michel	*Received at ESRF:*

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Report:

In this experiment (ME-208) were tomographied at beamline ID15 samples cut from tantalum targets previously shocked by high-velocity impact, at pressures from 6 to 13 GPa (Fig. 1). Shock induces damage under the form of inner voids (Fig. 3), in three different stages : nucleation, growth and coalescence up to ductile fracture in the target along a plane prependicular to the impact axis (*spalling)*, for high enough shock pressures and/or durations. The aim was to study the porosity repartition and statistics, of interest for comparisons to predictions of damage models at the intermediate growth stage.

The experiment used a CCD camera (Frelon), according to a new set up of beamline ID15 devised by Marco Di Michel and al. Tomography time is 4 mn per sample, while reconstruction as a collection of slices (Fig. 2) takes between 4 to 6 hours.

Forty samples were tomographied, but we could only get three 3D reconstructions (from an ID15 in-house program) due to the workload of the ID15 team. The 3 samples were little parallelepipeds of size 600x600x3000 μm^3 cut in different targets, tomographied at 65 kV.

1. In the sample shocked at 13 GPa (Fig.4), fractures are present, which indicates that we have entered the last step of damage, not accounted for in our model at the moment (a common limitation of models currently used to study shock-induced ductile damage in metals).

2. In the sample shocked at 8.7 GPa (shock duration : 0.25µs), some damage shows up (Fig. 5), however, not enough holes are present.

3.The sample shocked at 6 GPa (shock duration : 0.6µs) features more pores (Fig. 6), with biggest size order 100 µm, which is comparable to the sample cross-section. All slices in this sample were analysed in order to estimate the porosity curve along the impact axis (cumulated pore cross-section / sample cross-section), see Fig. 6.

However, due to the smallness of the samples (a limitation imposed by Lambert’s law), we couldn’t get a sufficiently good statistics to obtain a meaningful pore size distribution curve. This problem can be circumvented by increasing the number of samples cut from neighbouring regions of the target, and by averaging over them ; hence the interest of having as much data sets as possible. The small number of data sets did not allow us to do so. At the present time, these results can only be considered as incomplete ones and are not suitable for publication. It is hoped that in the future, it will be possible for us to do the required numerous reconstructions by ourselves at the beamline location, in collaboration with the beamline staff, so that we can complete our data collection without too much increasing the team workload.

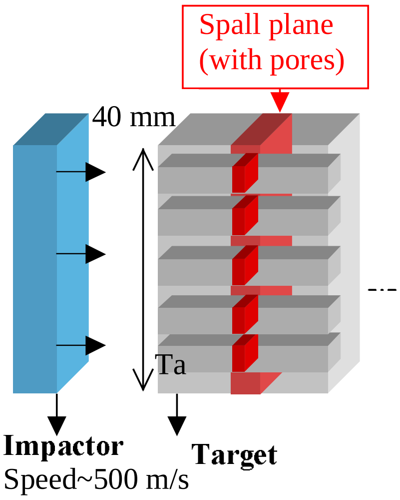

Fig.1 : Typical setup of impact experiment. Maximum damage occurs in the spall plane.

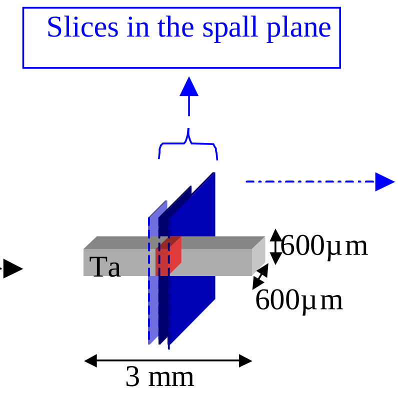

Fig.2 : Geometry of the cut sample. 2D virtual slices are obtained by microtomography (thickness : ~5µm)

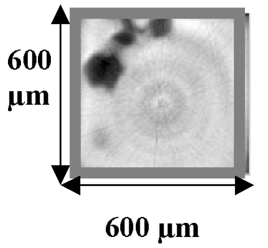

Fig.3 : Results on Ta : typical slice in spall plane (pixel ~ 5µm)

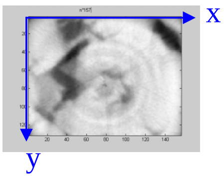

Fig.4 : typical slice for shock pressure of 13 Gpa.

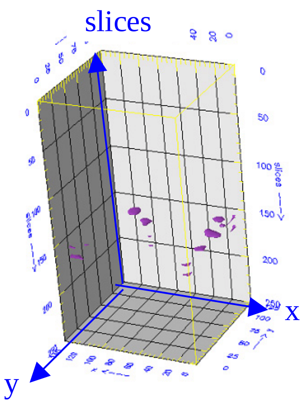

Fig.5 : 3D Visualisation of sample impacted at 8.7 GPa

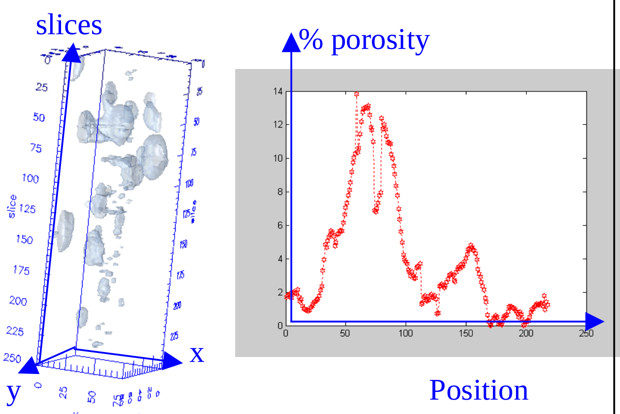

Fig.6 : 3D visualisation of sample impacted at 6 Gpa and porosity curve along the impact axis.