TEM OBSERVATION AND IN SITU COMPRESSION TESTS OF TRANSITION ALUMINA PREPARED BY HIGH PRESSURE COMPACTION AT ROOM TEMPERATURE

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The behavior of ceramics at the nanometer scale strongly differs from the one of the corresponding bulk material. For instance, strong plastic deformation has recently been reported in isolated nanometer-sized alumina nanoparticles or MgO nanocubes, when tested *in situ* in a transmission electron microscope (TEM). This plastic behavior may also occur in a powder during the compaction process, even at room temperature. Controlling plastic deformation of nanoparticles during the ceramics processing might be a way to enhance their properties or to improve the processing route (compaction and sintering steps, for instance). We present here a comprehensive study of the mechanical behavior of transition alumina in the compacted powder.

Transition alumina nanoparticles have been compacted at room temperature under different uniaxial pressures (5 GPa, 15 GPa and 20 GPa) in a diamond anvil cell or in a Paris-Edimbourg press. Thin foils of these compacted powders can be prepared by Focused Ion Beam machining (FIB) and analysed by TEM (figure 1a). High ResolutionTEM observations and diffraction patterns analyses unambiguously revealed that nanoparticles underwent plastic deformation in the compacted powder. A study of these HRTEM images coupled with Fast Fourier transforms to get the associated diffraction patterns show that the deformation involves the {110} lattice planes, and the slip system {111} <110>. These observations are in agreement with the deformation observed on a single nanoparticle during an in situ nanocompression test inside a TEM. Moreover at high pressure, phase transformation can be evidenced.

To go further on the understanding of mechanisms that may occur during compression of a powder, thin foils have been prepared from the compacted powder and tested in situ in a TEM (Figure 1b). Several imaging conditions have been investigated to follow the nanoparticle movement and/or their deformation during the compression. First results obtained on the compression of thin foils will be presented and discussed.

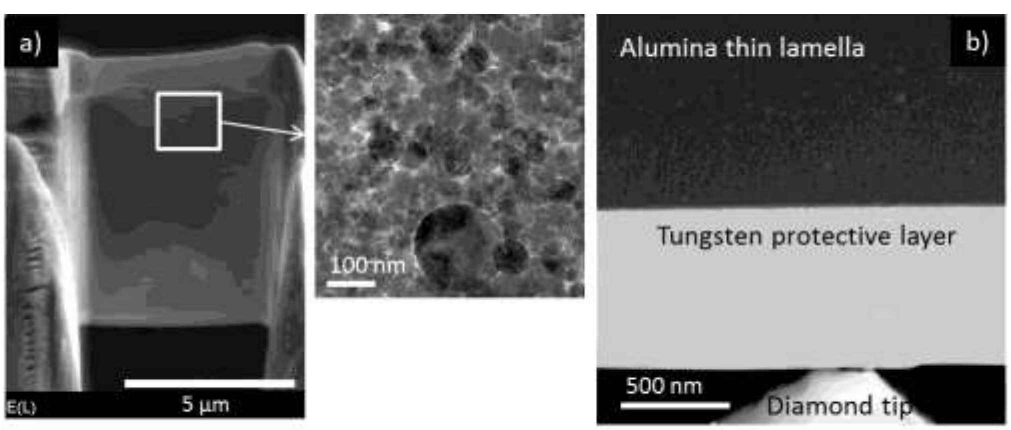

Figure 1 – a) alumina thin lamella prepared by FIB milling, b) alumina thin lamella during in situ nanocompression experiment in TEM observed in STEM mode