Surface-Finishing of Focused Ion Beam Milled Features by Pulsed Electron Irradiation

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It is well known that Focused Ion Beam (FIB) milling of polycrystalline samples often results in uneven final surfaces. The reason for this is the differential sputter yield for grains with different orientations caused by the so called *Channelling Effect.* This is when along certain crystallographic directions the bombarding ions can penetrate (channel) deeper into the crystal lattice, thus causing reduced sputter yield[1].

Unfortunately, existing methods of smoothing the FIB milled surface by "blocking" the channelling directions with injected gas molecules[2] or by increasing the sputtering yield ratio between the metal lines and the underlying insulators[3] are specific to circuit editing techniques and difficult to implement for applications such as mould fabrication.

In a previous study[4] it was demonstrated that heat treatment and control of the grain size of brass mould inserts is a possible solution to the problem. In this study a novel finishing technique using broad beam pulsed electron irradiation[5] to rapidly remelt the surface of FIB milled features is proposed. It is found that irradiation can reduce the roughness of 10μm square FIB machined trenches in brass from nearly 50nm Ra value to below 30nm (see Fig. 1).

Additional work includes refinement of the electron beam parameters to further improve the surface finish and control the dimensional accuracy of processed FIB features in a wider selection of materials.

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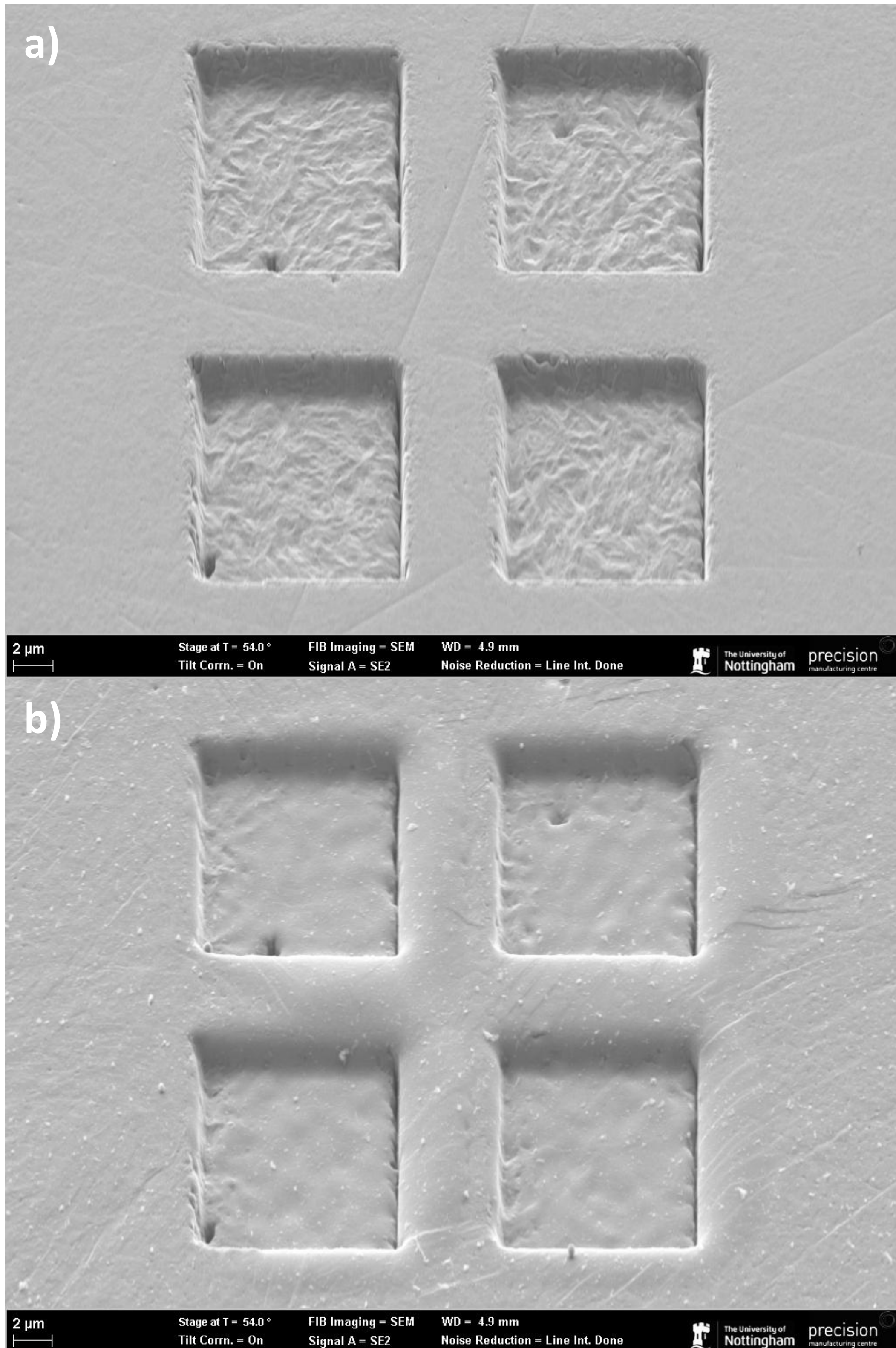

Figure.1 FIB milled 10x10µm trenches **a)** as machined and **b)** after pulsed electron irradiation. The initially uneven surface is noticeably improved.