Advantages of Broad Ion Beam (BIB) Processing Compared with Focused Beam (FIB) Technology for 3D Investigation of Heterogeneous Solids

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Ion beam processing of heterogeneous samples has proved as a versatile method for 3D inves tion of microstructures. Broad ion beams are used for conventional ion etching, polishing, ning, depth profiling and also for cutting [1]. With introduction of liquid metal ion sources the technology was developed especially for TEM sample preparation but also for SEM observa where both technologies are complementary. BIB processing has essential advantages comp with FIB technology concerning the productivity, the versatility especially in multi-step prc sing, the variety in the fields of application and the simplicity in practice and therefore lower of the available technique. FIG. 1 shows the characteristics of broad ion beam processing fo investigation of microstructures. With ion beam direction IB 1 slope cutting is performed typically 5 to 10 keV inert gas ions over some millimetres in length and up to the required d (e.g. up to 100 µm). Optionally rocking of the sample can be used to avoid ion beam induced rows. The 10000 times larger cut area and the application of inert gases with relatively low gies are some of the advantages compared with the FIB technology where 30 keV Ga ion applied to cut small areas of typically 10 µm laterally and vertically. In BIB applica additional ion beam processing steps can be used for polishing of the slope or selective etchi reveal the internal microstructure not only of the slope cut itself but also of the initial surface the sputtered region. In cases of insulating samples the third step of sputter coating is perfo with the same ion beam. These capabilities will be demonstrated with the investigation of YAG laser irradiated (Ti,Al)N layers on WC/Co substrates. The laser modified region was c broad ion beam slope cutting with the modified Gatan PECS and in selected micro-regions FIB (FIB FEI 200). The PECS allows combined processing of cutting, etching, and coating The information gain with both technologies is seen in FIG. 2 to FIG. 5. FIG. 2 shows the c system produced by the laser irradiation and selectively etched by 8 keV Kr ions. FIG. 3 sl the same surface together with the cutting line and a FIB cut crater in the SEM. The groove formed by physical sputtering. On this way the crack system can be observed by o microscopy with automated image analysis. The cut through the entire (Ti,Al)N layer reveal crack development into the third dimension (cutting under 60° to the initial surface). By the technology (FIG. 4) only a single crack can be observed - and the FIB cut shows projection facts in the ion beam direction. This can be misinterpreted as an influence of the crack int substrate. The broad ion beam cut reveals the system vertically (hundreds of c simultaneously) through the entire laser spot and allows exact interpretation. Typical crack seen in FIG. 5a,b. The inspection showed no influence of the cracks into the underlying substra

References

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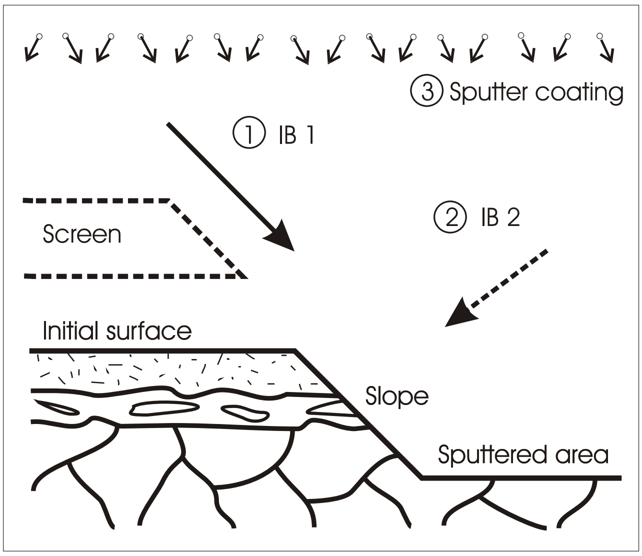

FIG. 1. Three broad ion beam processing steps for 3D investigation of heterogeneous solids. SEM observation of the initial surface, slope area, and sputtered area generally in direction of IB 2
1 Ion beam direction for cutting
2 Ion beam direction for selective etching
3 Sputter coating

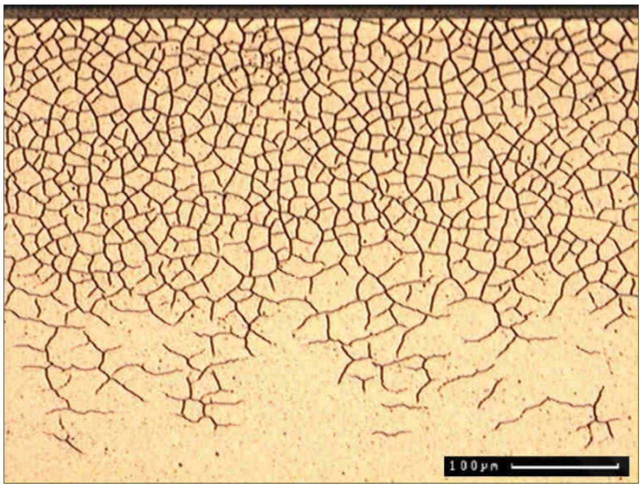

FIG. 2. Crack network within the laser spot on (Ti,Al)N-WC/Co after selective ion beam etching. Dark border above: BIB cutting line accross the laser spot (Optical microscopy)

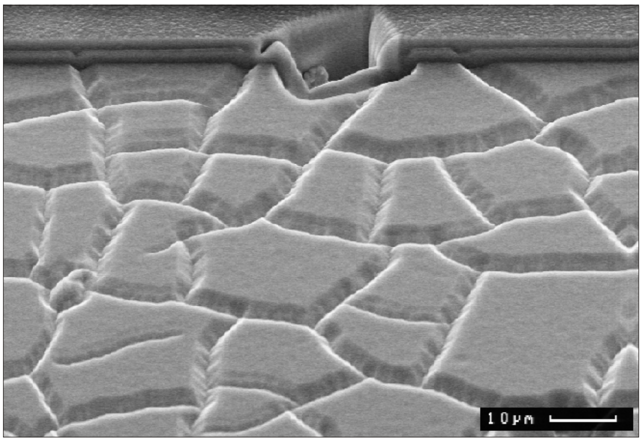

FIG. 3. SEM image of the crack network after ion etching compared with the non-etched initial surface (above) and a FIB cut crater

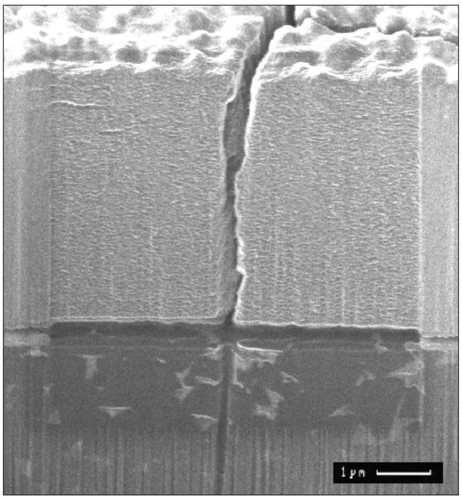

FIG. 4. FIB cut though a crack in the (Ti,Al)N layer on WC/Co substrate with an ion beam projection artefact into the WC/CO substrate (FIB imaging; secondary electrons)

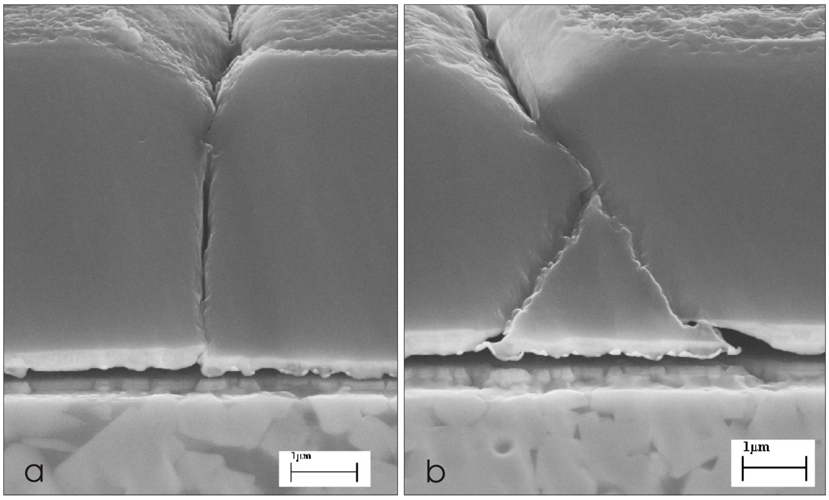

FIG. 5 a and b. Broad ion beam slope cut through typical cracks in the (Ti,Al)N layer without ion beam projection effects into the WC/Co substrate. Selective ion etching shows the cracks and the delamination effects
(FESEM imaging with LEO Gemini 1530)