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Nanoscale Strain Mapping During in situ Deformation of Annealed Al-Mg Alloys

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Al-Mg alloys represent an attractive option for weight-sensitive applications such as exterior car paneling, but serrated flow during plastic deformation limits their applicability (due to both poor formabilty and strain rate sensitivity for impact qualifications). Although serrated flow is a commonly experienced phenomenon during plastic deformation of these alloys [1], the fundamental dislocation processes responsible remain poorly understood. Recent advances in local strain mapping using nanobeam electron diffraction (NBED) have demonstrated the ability to observe single defects and the strain fields around them [2]. By observing dislocations, their strain fields, their movement under stress, as well as their interactions with each other and precipitates, we aim to provide insight into the fundamental mechanisms of serrated flow.

In this work, we show an example of in situ strain mapping in an Al-Mg alloy involving several dislocations. In situ TEM annealing was used to mitigate some of the damage from the focused ion beam (FIB) milling prior to mechanical testing [3]. NBED was used to obtain the strain mapping. Figure 1 shows an example pillar before compression, with several dislocations present and a minimum of damage. These pillars were then compressed with a Hysitron PI-95 picoindenter while diffraction patterns were continuously obtained. The resulting dataset contains diffraction data for every point of the STEM image, from which strain maps were extrapolated. Figure 2 shows a preliminary result from the work performed. Figure 2a is a strain map obtained before stress was applied, whereas 2b is a virtual dark field image calculated from the set of diffraction patterns in the same sample [4], clearly showing dislocations present.

We will present initial results of this new technique with the goal of elucidating the fundamental mechanism of serrated flow via in situ strain mapping. This technique offers quantitative measurements of strain around features of interest on a scale not previously possible during in situ deformation.

[1] W. Wen and J. G. Morris, Materials Science and Engineering: A **354** (2003) p. 279.
[2] V. B. Ozdol *et al*, Applied Physics Letters **106** (2015) p. 253107.
[3] M. B. Lowry *et al*, Acta Materialia **58** (2010) p. 5160–5167.
[4] C. Gammer *et al*, Ultramicroscopy **155** (2015) p. 1–10.
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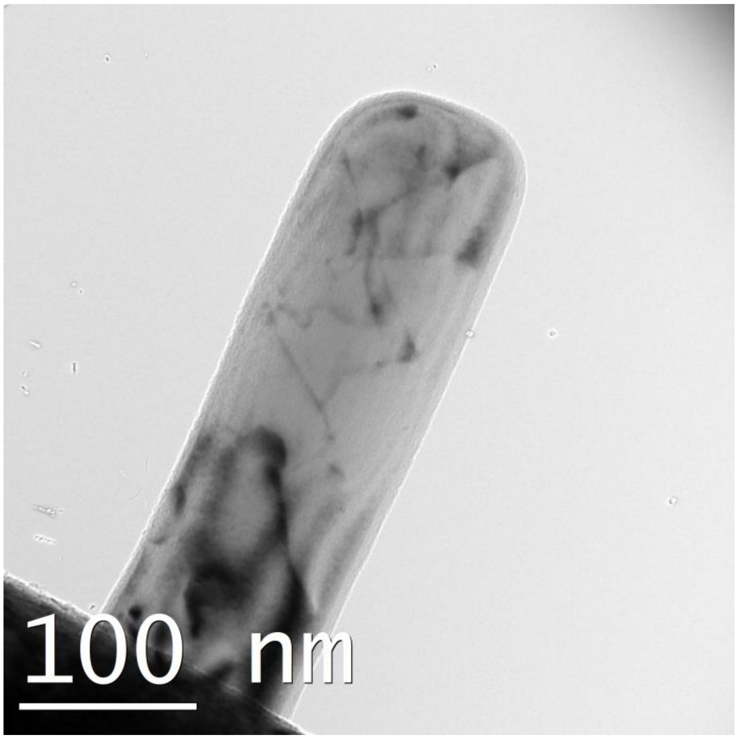

Figure 1. Pillar before indentation showing several dislocations interacting and lack of FIB damage.

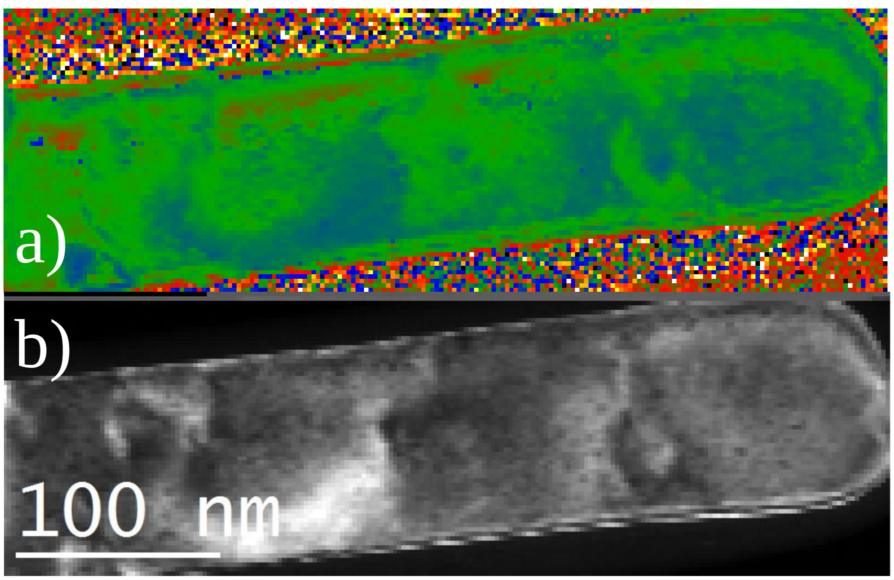

Figure 2. a) Strain map of pillar with strain fields around dislocations before compression. b) Virtual dark field image clearly showing location of dislocations.

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