

A combined laser ablation/focused ion beam approach to atom probe sample preparation

Byrnes, J.¹, McCarroll, I.² and Cairney, J.²

¹ Sydney Microscopy and Microanalysis, Australia, ² Australian Centre for Microscopy and Microanalysis, Australia

Here, we explore a combined laser ablation and focused ion beam (FIB) protocol designed to significantly increase the throughput of atom probe sample preparation. Atom probe sample preparation typically involves in-situ lift-out processes using FIB [1]. The FIB lift-out process is an expensive and time consuming technique that requires skilled technical staff to operate; meaning access to instrument time and training significantly hinders the throughput of atom probe preparation. Recently, a method utilising shadow masks during broad ion beam (BIB) milling, for initial stage atom probe sample preparation, was demonstrated [2]. This approach improved atom probe sample throughput of non-conductive and multi-layered materials by minimising the time required on the FIB and the skills required of the FIB operator.

The current study focuses first on optimising a laser ablation protocol for in-house rapid preparation of shadow masks required for the broad ion beam approach. Design optimisation of the shadow masks for improved FIB preparation and atom probe analysis will also be considered at this stage; an example of the current shadow mask design and proposed design optimisation are presented in Figure 1. The protocol will initially be optimised for W due to its proven success as a masking material [2]. Once the protocol has been established for W, it will be adapted for preparation of more complicated specimens, such as those containing oxide layers or thin films. Once prepared, the laser-cut atom probe tips can be further processed via FIB annular milling to form suitably sharp tips for atom probe tomography, approximately 100-200 nm in diameter. This approach will eliminate the need for either FIB lift-out or BIB milling with shadow masks, improving the efficiency and reducing the complexity of atom probe sample preparation.

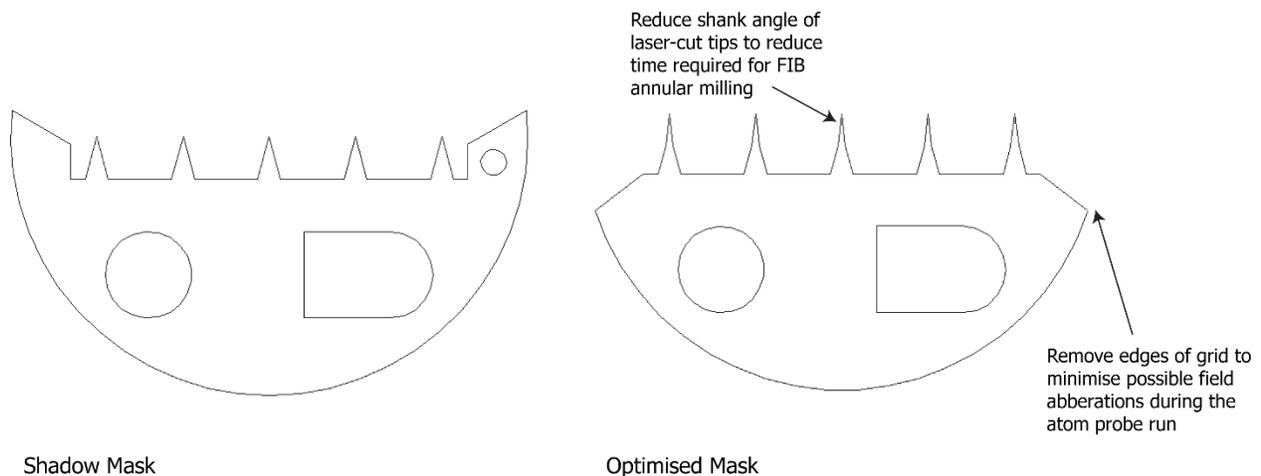


Figure 1: Schematic of a shadow mask for BIB milling, along with an example of possible design optimisations.

References

- [1] J.M. Cairney, D.W. Saxey, D. McGrouther, S.P. Ringer, Site-specific specimen preparation for atom probe tomography of grain boundaries, *Physica B: Condensed Matter*, 394 (2007) 267-269.
- [2] P. Felner, I. McCarroll, C. Macauley, J.M. Cairney, A simple approach to atom probe sample preparation by using shadow masks, *Ultramicroscopy*, 160 (2016) 163-167.

