Plan View FIB Specimen Preparation With Vacuum-Assisted ex situ Lift Out

Giannuzzi, L.[1], Lowery, L.M.[2], Lu, P.[2], Kotula, P.[2] and Michael, J.[2]

[1] EXpressLO LLC, United States, [2] Sandia National Laboratory, United States

Plan view focused ion beam (FIB) specimen preparation for scanning/transmission electron microscopy S/TEM is possible but rarely performed due to its complexity and time-consuming process. Plan view specimens have been FIB prepared from pre-thinned or "H-bar" samples [1,2], via *in situ* lift out methods [3,4] or via *ex situ* lift out methods [5,6]. These traditional techniques require either initial sample thinning, or multiple sample and/or grid rotations or manipulations to correctly orient the region of interest. In this abstract, we describe a novel and efficient vacuum-assisted *ex situ* lift out technique for plan view FIB specimen preparation.

We start with a 20 x 20 μm region protected via electron beam deposited Pt followed by FIB deposited Pt. A pattern in the shape of a "U" is FIB milled in parallel mode at 45° - on each side (i.e., 7° stage tilt on an FEI Helios 660/G3 UC DualBeam) using a 180° stage rotation to create an unsupported and free-standing wedge-shaped sample. The bulk sample is moved to an EXpressLO Nicola 800 *ex situ* lift out station equipped with an Aspirato vacuum module where a 30° beveled hollow probe is used for the lift out to slotted EXpressLO grids [7]. The lift out steps are shown in Figure 1. After FIB milling, conventional S/TEM or high resolution S/TEM is possible. Results of this method applied to prepare plan view specimens of Si and a ZnO:$LaSrMnO_3$ composite thin film grown epitaxially on $SrTiO_3$ substrate by pulse laser deposition will be presented.

This vacuum assisted *ex situ* lift out plan view method is fast and easy and eliminates expensive FIB time required for *in situ* lift out and complicated sample and/or grid manipulation. The slotted EXpressLO grids provide precise sample placement and stability, and allows for standard FIB processing necessary to create conventional TEM or high resolution STEM quality specimens [8].

References:

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[8] Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

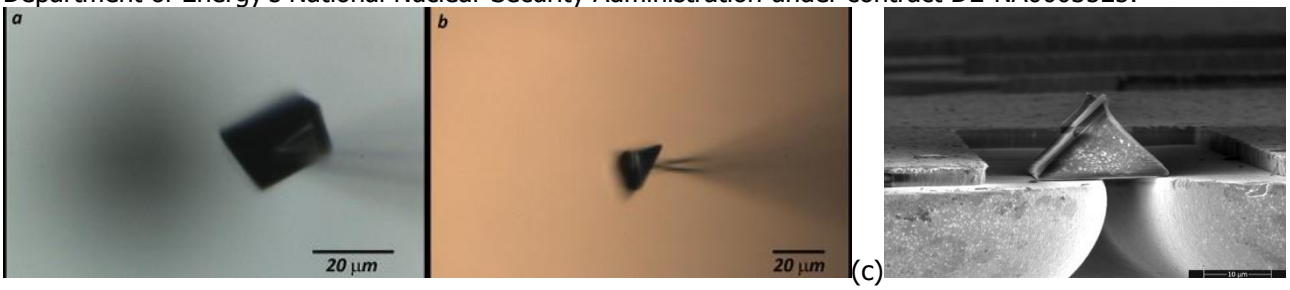

Figure 1: Vacuum-assisted *ex situ* lift out of a FIB milled (001) plan view Si specimen (a) lifted out from the bulk sample. (b) probe rotated 180°. (c) SEM image of plan view sample orientation prior to thinning.