534 Microsc. Microanal. 23 (Suppl 1), 2017
doi:10.1017/S143192761700335X

Crystallographic Orientation Image Mapping with Multiple Detector Configurations at 30 – 300 kV

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The acquisition of 2D diffraction patterns from an array of 2D points in a scanning electron beam experiment is a 4D experiment that can be used to map local crystallographic orientations. The automated acquisition and analysis of these Kikuchi diffraction patterns [1, 2] has enabled orientation mapping of crystals with a large range of length scales. For example, commercially available electron back-scattered diffraction (EBSD) systems for an SEM are capable of measuring micron- and sub-micron–scale features over length scales of 1 cm using automated montaging techniques. However, the pursuit of crystallographic features that are 10 nm or smaller requires the use of transmission-based techniques available in both SEM and TEM. There have been several advancements in automated analysis of diffraction patterns that have enabled the ability to perform automated Kikuchi diffraction experiments in a variety of microscope configurations [3-6]. At accelerating voltages of 30 kV and lower, it is now possible to perform transmission Kikuchi diffraction (TKD) experiments using a conventional EBSD detector and an SEM to study features 10 nm and smaller. In addition, the use of scanning precession electron diffraction (PED) has enabled experiments with similar spatial resolutions for spot diffraction patterns in TEMs at accelerating voltages of hundreds of kV.

Here, we will compare transmission electron diffraction experiments on Au and Pt films using different microscope/detector configurations and at different accelerating voltages. Electroplated Au films are important for long-lived electrical contacts and an understanding of the relationship between grain structure and processing conditions is important for predicting the long-term reliability of electrical contacts. Electroplated Au therefore serves as a good model system for directly comparing different transmission diffraction analysis schemes. At 30 kV we will compare transmission Kikuchi diffraction experiments performed using a conventional EBSD detector orientation (Figure 1a) with experiments using a horizontal detector head (Figure 1b). In addition, we will compare orientation mapping results from sputtered Pt film collected by both TKD at 30 kV and PED at 200 kV (Figure 2). The advantages and challenges associated with each experimental approach will be discussed.

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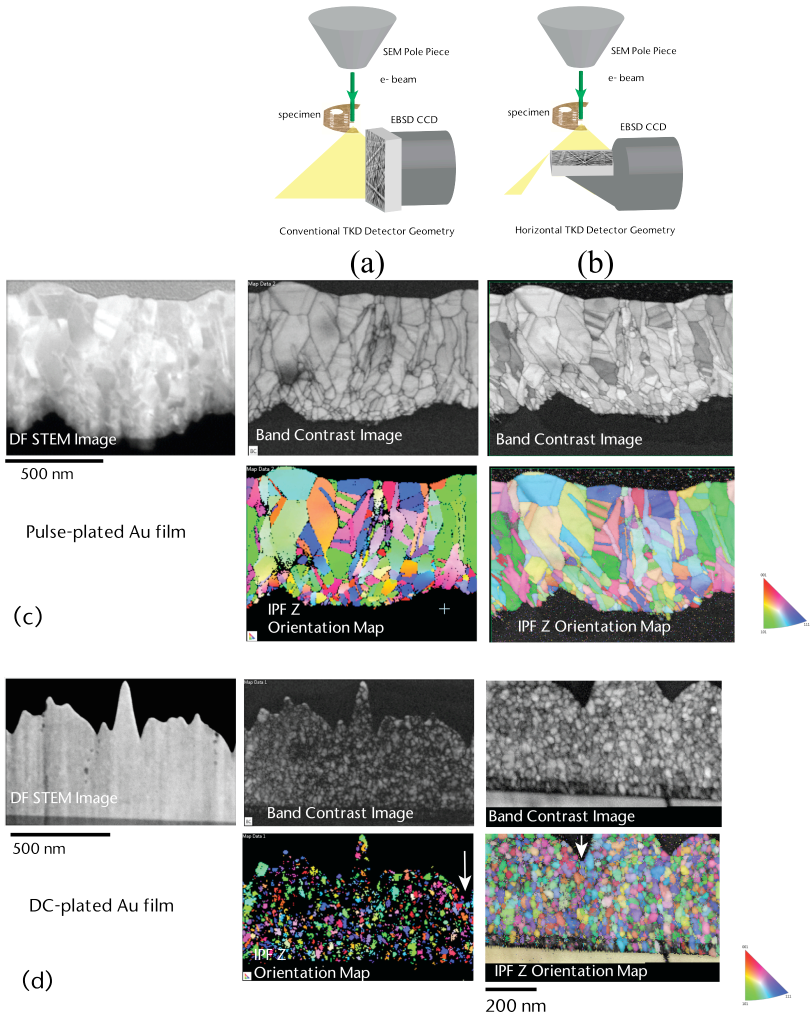

Figure 1. Schematic showing conventional TKD geometry in an SEM (a), horizontal TKD geometry (b), and corresponding images collected for a pulse-plated Au film (c) and DC-plated Au film (d). Images below (a) were collected with conventional geometry, and images below (b) were collected with horizontal geometry. The same regions of the sample are shown for both conditions. In (d), a white arrow points to the same feature in both detector configurations.

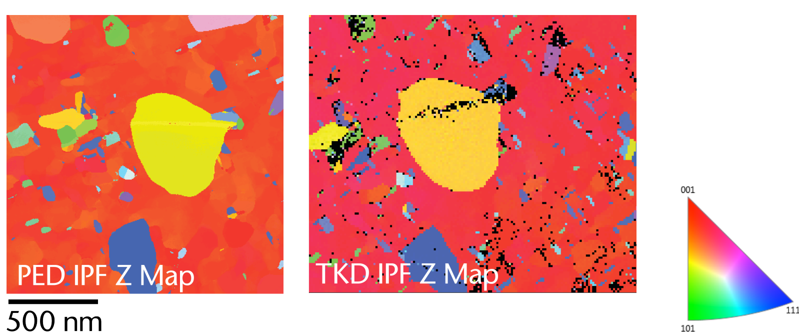

Figure 2. Direct comparison of precession electron diffraction (PED) IPF Z map acquired with a TEM at 200 kV and a TKD map acquired at 30 kV on the same region of a 40-nm thick Pt thin-film sample.

https://doi.org/10.1017/S143192761700335X Published online by Cambridge University Press