Exploiting the Binocular Head in Polarized Light Microscopy

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Having been brought up on monocular microscopes I find the omnipresent binocular systems a luxury. To support this viewpoint I'd like to suggest some benefits you may not have considered.

Because I'm used to monocular viewing I sometimes use two different oculars, say 10X and 25X, in order to scan quickly to find an area of interest and then to examine the detail with higher magnification. Occasionally I use both oculars simultaneously and "concentrate" on either image to the exclusion of the other. A better way is to set the interocular distance at the extreme setting most different from your own interocular distance. By moving your head about a centimeter either way you can use either ocular.

A variation of this theme is very helpful when you are trying to find good crystals showing useful interference figures. I simply replace one ocular with a pinhole (thoughtfully supplied by the manufacturers with all polarized light microscopes - for reasons of habit only, I'm sure). The pinhole yields a small but very sharp interference figure without the Bertrand lens. With the ocular tubes set for normal binocular viewing one can observe each crystal and, superimposed on it, the corresponding interference figure. One can, by this means, scan a field of dozens of crystals in a minute or so to select a useful view. Only the crystal or area at the very field-center will contribute to the interference figure. For measurements of optic axial angle one then inserts the Bertrand lens for normal conoscopic viewing of the crystal located by the pin-hole method.

Finally, stereo imaging is easy by changing the interocular distance a few mm so that each eye looks through an outer (properly stereoscopic) or inter (pseudo-stereoscopic) edge of the oculars. I can think of some other ideas but they seem a bit too far out even for me (e.g., having an analyzer over one ocular would give crossed polars with one eye to compare with the single polar view; a very tiny, about one mm, aperture at the eyepoint of one ocular would yield annular stop dispersion staining; a tiny one mm opaque stop similarly placed would yield central stop dispersion staining, etc., etc.). Still, one other practical idea is to insert a light meter in one ocular tube to record light intensity of fusion preps as they are heated to detect solid-solid phase changes and melting points you observe directly through the other ocular. ■

Site-Specific Cross-sectioning of IC Devices for Failure Analysis by SEM/TEM: Specimen Preparation Challenge and Approach

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Cross-sectioning of microelectronic devices for the purpose of construction or failure analysis by SEM and/or TEM has always been considered a major challenge. The ever increasing complexity and shrinking dimensions of these devices have pushed the art and science of the related specimen preparation beyond their conventional limits. The need for SEM failure analysis of sub-micron elements of a failed device requires the capability of cross-sectioning the sample with a high spatial-resolution within a specific transverse plane. An image of the device structure obtained at sufficiently high magnification from the above specimen generally reveals the defect(s) responsible for the failure. If the imaging resolution and contrast offered by an SEM prove to be inadequate for the above purpose, device structure will be inspected via TEM. Analysis of such device by TEM imposes the additional requirement of back-thinning the above specimen to electron transparency at the site of failure.

The above challenge is currently approached through two different techniques: a) manual grinding and polishing to expose the specific site of interest in cross-section (for SEM analysis) followed by manual/mechanical micro-thinning from the back-side to electron transparency at the same site (for TEM analysis), or b) forming a rectangular microcrater adjacent to the site of interest using a focused ion-beam (FIB) such that a crater wall intersects and reveals the feature of interest in cross-section (for SEM analysis). Ion-milling a second crater next to the first one with a side-wall intersecting the site of failure from the opposite side forms an ultra-thin electron-transparent section containing the feature of interest (for TEM analysis).

The latter technique (technique b), if used for TEM samples, also requires the following manual grinding and polishing steps prior to the FIB processing. Figure 1 schematically shows a typical FIB-milled cross-sectional TEM (FIB-XTEM) specimen. Depending on the personal preference and/or level of skill, the TEM specimen preparer may take either the "single-sided" or "double-sided" FIB milling approach. In either case, initially, he needs to prepare a thin transverse section, known as a "mechanical slice", from the device under study containing the structural feature or specific site of interest. For single-sided FIB-milling, one side of the above slice must intersect and expose the feature of interest. Subsequently, back-thinning via FIB is performed only from one side, as shown in Figure 2. In double-sided FIB-milling, as presented in Figure 3, the mechanical slice does not expose the site of interest. Therefore, FIB-milling is required from both sides of the slice. The tool and the materials needed to accomplish above the manual preparation tasks are generally very similar or identical to those used in the former procedure (technique a).

Technique a is highly skill-based and the tool and material requirements are minimal. In contract, the FIB technique is mainly machine-based and the challenge to the specimen preparer is much more manageable. In addition, the precision offered by a FIB system unquestionably surpasses that of the manual sectioning and micro-thinning. Rather than comparing pros and cons of each technique, it is more reasonable to accept that they are complementary because each one offers some distinct and crucial capabilities to the IC device failure analyst. ■

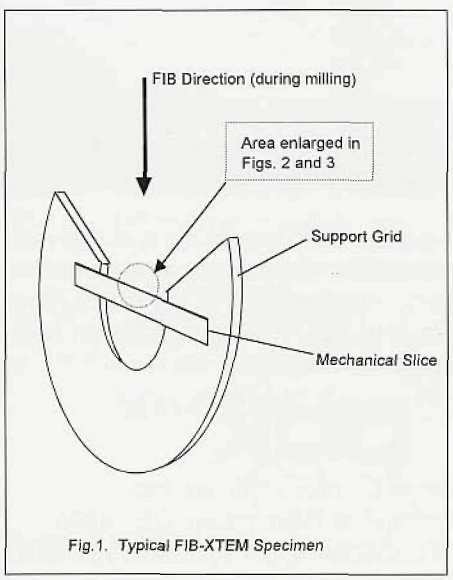

Fig.1. Typical FIB-XTEM Specimen

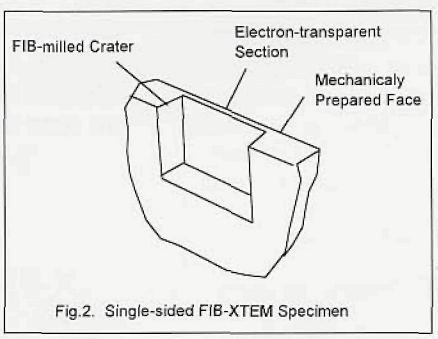

Fig.2. Single-sided FIB-XTEM Specimen

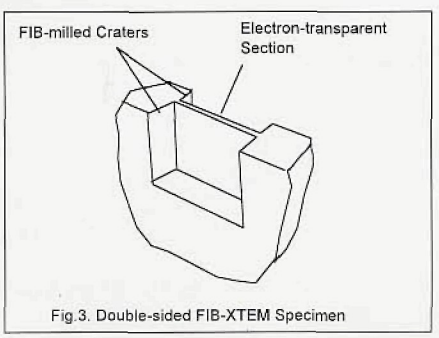

Fig.3. Double-sided FIB-XTEM Specimen