

APPLICATION NOTE

Materialography by optical microscopy

The properties of materials such as plastics, glass, ceramics and metals as well as interconnects of these materials are important for their correct functionality. Optical microscopy is a powerful technique to study properties like structure, grain size and layer thickness. Generally, such studies are performed in cross-section. Correct cross-section sample preparation is the key factor to obtain valuable information on these materials.

Cross-section sample preparation

A good cross-section preparation routine implies that the material's properties are not changed along the route. Therefore, great care must be taken when choosing: embedding mass, polishing agents (mechanical, electrolytic), etching type (chemical, electrolytic, ion bombardment), contrast method (chemical, electrolytic, deposition, sputtering), etc. Our laboratory possesses substantial expertise in each of these areas. Often a cross-section preparation process is optimized in close collaboration with the customer.

Optical microscopy

Our optical microscopy laboratory offers a full range of optical microscopy techniques, each dedicated to the properties of study. The most important methods that are used to visualize different features are:

- *incident/transmitted light*
- *bright field imaging* to visualize small assemblies, structures, joints, phases, etc.
- *dark field imaging* to look for binder distribution in granules
- *polarization contrast* for structure in titanium, aluminum, soldering joints, plastics, failure in dielectric materials, stress in materials, etc.
- *interference contrast* (ICR in reflective mode and ICT in transmission mode) to visualize structures in materials with poor etching properties by means of the differences in surface level
- *incident light in combination with fluorescence*: detection and investigation of fine cracks and defects in metal surfaces, detection of contamination on masks, wafers, pads and complex groups of organic particles.

If details are too small to be visualized using optical microscopy, additional SEM studies can be performed. The cross-sections made can also be used for mechanical testing (like Vickers' hardness measurements).

A typical application: quality check of laser weld joint

In this example, the sample consists of a phosphor-bronze strip that is wound with a copper wire. To guarantee a good connection between the Cu-wire and the strip, soft solder is applied. The question here was to check the quality of the joint after laser welding of the soft solder.
In order to prevent delamination of the joint during handling and preparation, the sample had to be fixated. For the fixation a so-called cold mount had to be used because of the low melting temperature of the soft solder. A preparation process was chosen incorporating mechanical grinding and polishing. After a first inspection, the cross-section was additionally etched using ion bombardment.
Figure 1 shows optical microscope images of the cross-section of the joint. The left figure (as polished) shows the porosity
by gas holes (black spheres) and the mix of phosphor-bronze and copper in the weld. The right figure (after etching by ion bombardment) displays heat effects on the crystallinity of the phosphor-bronze close to the weld. Also, the material structure in the weld itself is visualized. For the materials used here, a high-quality laser weld was obtained. Only the heat- affected zone is a little too large. With this information we can support the process engineer to optimize the laser-welding process.

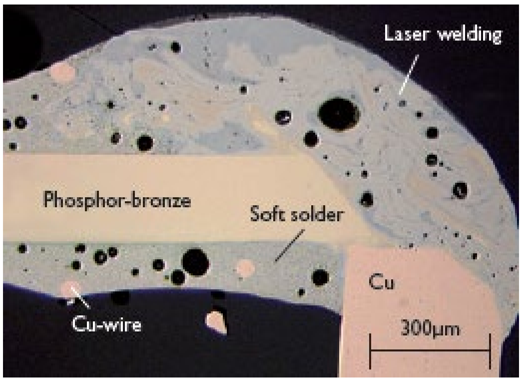

Figure 1: A joint made using laser welding. This optical microscope image of a cross-section was taken in bright field mode directly after polishing.

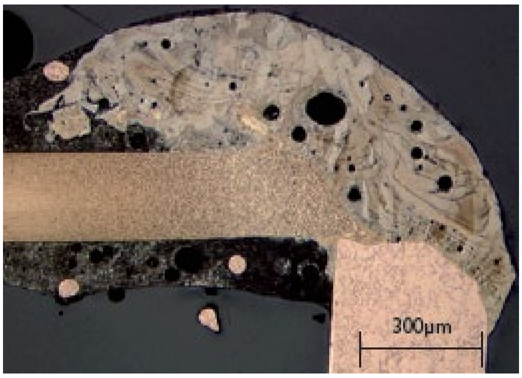

Figure 2: the same joint as in figure 1, imaged after additional etching using ion-bombardment. The additional etching enhances surface structures, as seen here in the phosphor-bronze close to the weld.

Typical Applications

- Optimization of the assembly building process.
- Measurement of layer thickness, size or distance inside assemblies.
- Porosity in a.o. plasma-spray coatings, ceramics.
- Quality of welding or soldering joints.
- Quantification of inclusions in all kinds of materials by image analysis.
- Grain size distribution in crystalline materials (crystal size > 0.5µm).