Underlying Structure of Engineering Materials

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Introduction

These videos were presented at the National Educator's Workshop, Update-98, held at Brookhaven National Laboratory, Nov 1-4, 1998. Detailed descriptions of how we made them and how they have been used in our courses are given in the paper, "The Underlying Structure of Engineering Materials" which was published in the proceedings. This paper is also available on-line at:

www.kstreetstudio.com/MatSci/NEW/NEW-Update-1998.htm

Background

In a number of the laboratory courses at U.C. Davis we conducted tensile tests on annealed brass. In some cases the annealing produces grain sizes of over one millimeter and during the tensile tests a pronounced orange peel surface is produced. While this is not something you'd want to see in a forming operation we thought it would make an excellent introduction to one of the most fundamental principles of materials science, the relationship between structure and properties. So we decided to make a video that would be show a shiny piece of yellow brass, which is how most people usually see brass, under conditions where the underlying structure would slowly reveal itself. We actually made two videos, one using a polished piece of brass and the other a polished and etched piece of brass, both being tensile tested, both viewed through a stereo-zoom microscope.

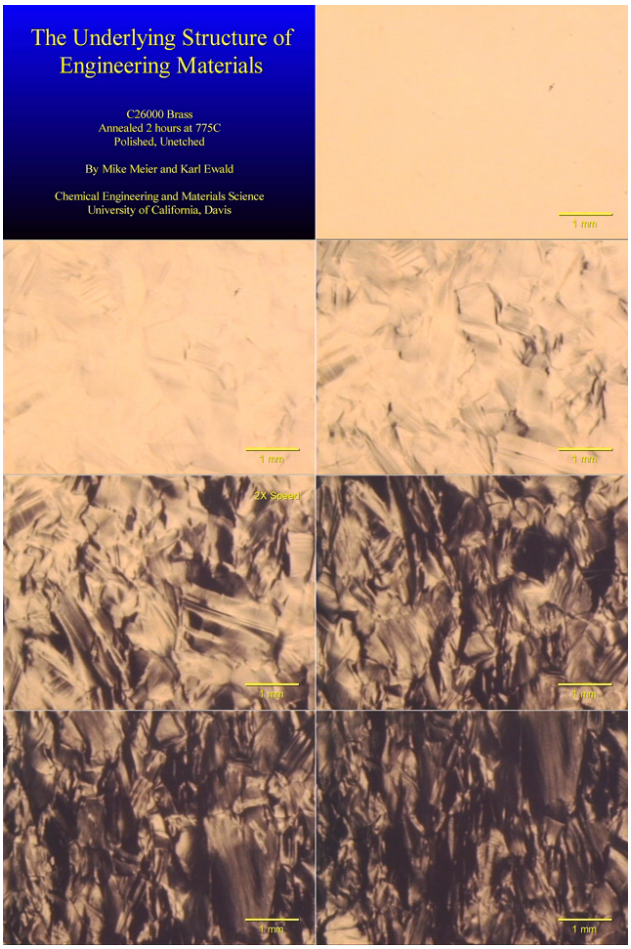

Figure 1 Frames from the first video.

In these videos the underlying structure appears almost as soon as the tensile test starts. Deformation bands develop, the grains themselves and even the twins become well defined. As deformation continues the surface becomes very rough, the grains elongate. Watch carefully the later part of the first video and you'll see how deformation appears to stop briefly, then resumes but as if a wave of deformation passes long the length of the sample.

Many of the materials we use are actually made up of an aggregate of many grains, each a single crystal, usually too small to see and usually not etched so that we cannot see any more than a bright, shiny metallic surface. Each grain will shear along preferred slip planes and under the

right conditions we might even be able to see the deformation bands produced by this slip. But since each grain is oriented differently with respect to the tensile axis slip will occur in different directions even if from a macroscopic viewpoint deformation appears to be isotropic. These grains are also being subjected to forces from neighboring grains, local stresses are acting upon each grain, the grains elongate, etc.

Videos

The two videos here are of the same material and had received the same heat treatment and use the same testing procedure. In the first video the sample is annealed and polished and shows the structure emerging from an initially smooth piece of metal. The second video shows a polished and etched specimen as it is tensile tested. One can see the microstructure before the tensile test starts.

Feedback

We'd appreciate hearing from anyone who has viewed these videos and especially from those who have used them in their courses. You can contact Mike Meier at:

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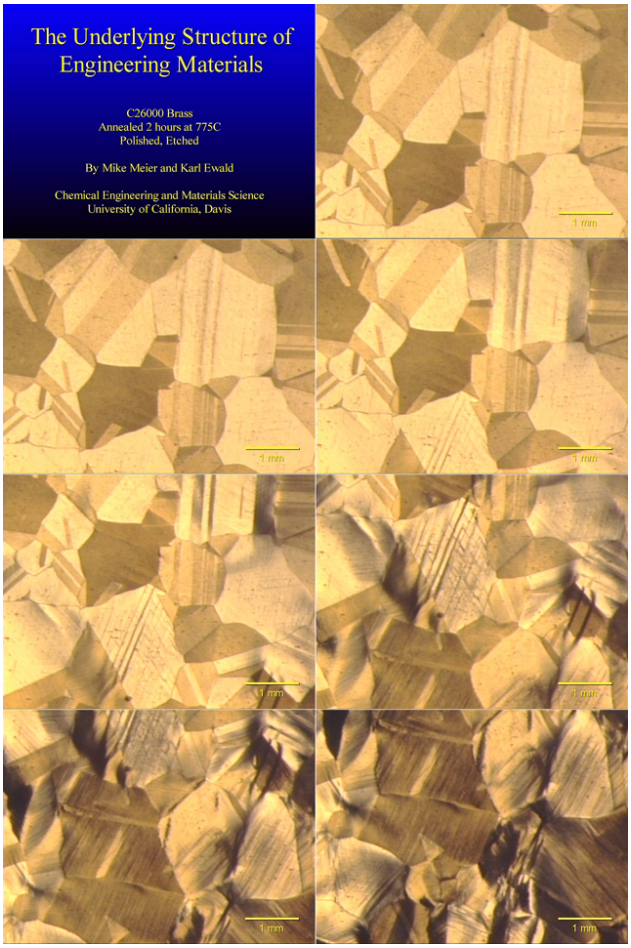

Figure 2 Frames from the second video.