Lucis Processing of Diffraction Patterns

Alwyn Eades
Department of Materials Science and Engineering
Lehigh University
5 East Packer Avenue
Bethlehem, PA 18015-3195

Electron micrographs and, more especially, diffraction patterns are very difficult to process so that a useful image can be printed onto paper. The problem arises because the images contain small details of low contrast set against a background which can have very large variations in intensity from one part of the image to another. For example, dislocations imaged in a field of view crossed by bend contours. Or, in a convergent beam pattern, one might want to see HOLZ lines against the very strong background of the bright-field disc at the same time as seeing faint features in the Kikuchi lines against a very dark background. As we look at the fluorescent screen of the TEM we can see these things because the fluorescent screen can give an enormous range of intensities and because of the way that the eye responds. The eye responds logarithmically and also (up to a point) uses different "brightness and contrast" settings for different parts of the image.

When the same image is printed onto paper, we are much more limited in what we see because of the limited range of densities that the paper can handle. Thus we are unable to effectively represent what we know we can legitimately see. There have been several ways of doing dealing with this problem. Before digital image processing, there was a darkroom technique called unsharp masking.

Many of us have been waiting for a software package to do the equivalent of unsharp masking. This means flattening the big variations of intensity across large areas while retaining the small changes of intensity at small features.

Lucis is a software package produced by Image Content Technology LLC, New Britain, Connecticut. It is simple to use and has proved most effective in processing convergent-beam patterns as well as normal micrographs. Images are readily copied back and forth from Lucis to Photoshop, for example, for other more standard manipulations.

I now consider that this will be a standard part of our image processing work, prior to printing. Until now, I have used Lucis on images scanned from photographic negatives. I expect that it will prove to be even more valuable when used with images acquired digitally from cooled CCD cameras, because these cameras have a wider dynamic range than film and the problems of proper printing will be still more severe.

Below is an example of Lucis processing.

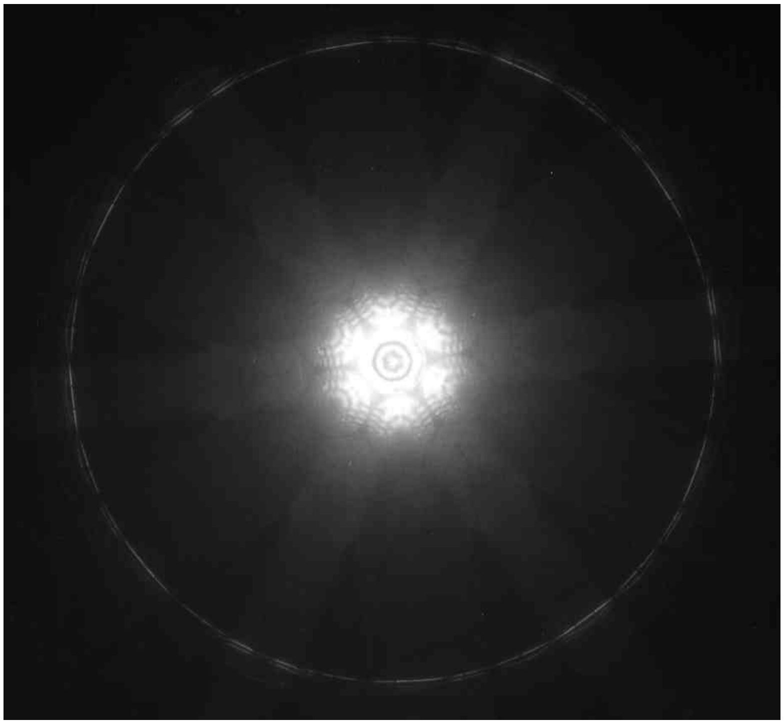

Figure 1: This image is a short-camera-length convergent-beam pattern from silicon at 100kV. I did as well as I could with standard "brightness and contrast" in Photoshop (I am by no means an expert with Photoshop). Notice that the center of the figure is overexposed and that details in the background can not be distinguished.

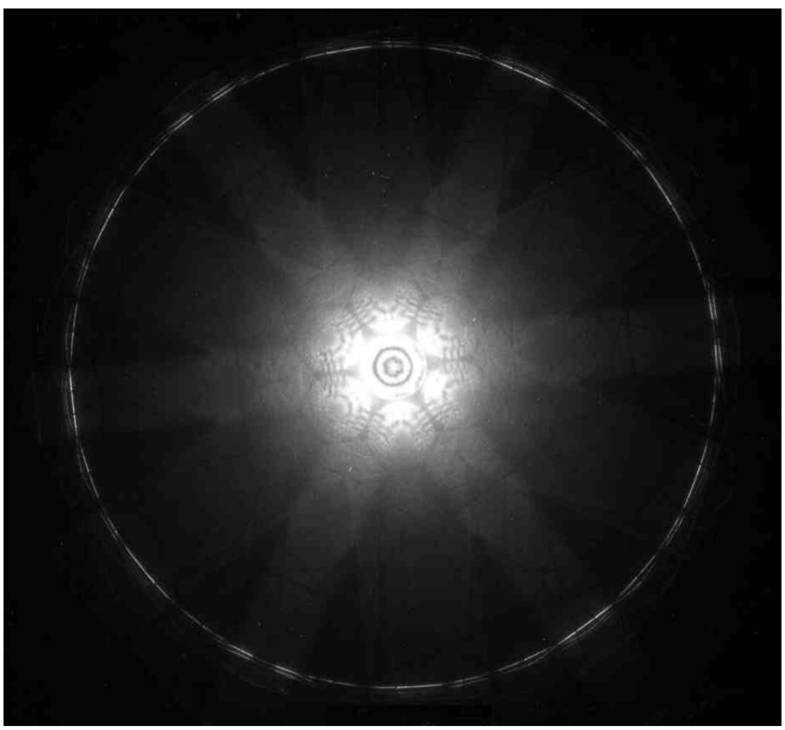

Figure 2: This is the same figure treated by Lucis. Now the HOLZ ring is clear, but more than that, Kikuchi lines can be seen in the diffuse background. The center of the pattern is not overexposed.