Opinion

One of my Failures: Diffraction in the TEM

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There are two principal techniques for obtaining diffraction patterns in the transmission electron microscope (TEM). They are selected-area diffraction (SAD) and convergent-beam diffraction (CBED). CBED is quicker and easier to use, and it provides a much richer characterization of the sample. Thus, it is clear that CBED should be used in the vast majority of cases. It should be the diffraction technique that students learn first, and students should be taught to consider it the standard method of doing diffraction in the TEM.

However, I still find that most young users with whom I talk have been taught SAD and do not know about CBED. Why does this anomaly exist? It arises from the history of the instruments. From the invention of the TEM until the mid-1970s, the lens configuration of all TEMs was such that CBED was not possible. SAD was invented and used instead. This means that every microscopist who learned the use of the TEM until the 1970s had no choice. They had to use SAD.

That changed when the design of microscopes changed. The lens configuration of commercial TEMs was changed, not to make CBED possible (though that certainly would have been reason enough), but to facilitate elemental analysis by energy-dispersive x-ray spectrometry (EDS). The same focused probe that was needed for EDS permitted the formation of the convergent beam for CBED. It also, incidentally, permitted imaging at higher resolution. Thus, commercial microscopes, from about three decades ago onward, have almost all been made with a lens configuration that facilitates CBED. (The exceptions are some simple microscopes designed for biological applications where neither diffraction nor EDS are relevant.)

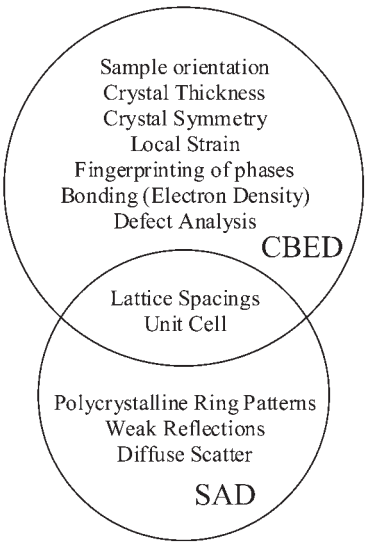

Figure 1: Diagram indicating information that is best obtained by convergent-beam electron diffraction (CBED) and by selected-area electron diffraction (SAD). The area of overlap corresponds to data that can be obtained by both methods.

So, from about 1980 on, students should have been taught to use CBED as their primary diffraction tool, but they were not. The reason, I believe, is simple. Those who did the teaching taught what they knew, not what was best. What they knew was SAD. Those students grew up and, in turn, taught their own students. So, thirty years later, students are still being taught, inappropriately, that they should use SAD.

Which experiments are best done by CBED (most of them) and which are best done by SAD (only a few) are indicated schematically in Figure 1 and discussed in: *When To Use Selected-Area Diffraction And When To Use Convergent-Beam Diffraction,* A. Eades, *Acta Microscopica* 17 (2008) 101–05. This article is available at: http://actamicroscopica.ivic.gob.ve/V17_1_2008/index.htm

I have spent a lot of time over the last three decades (in writing, at short courses, at conferences) trying to communicate the idea that CBED should be the preferred method. Clearly, I am not very good at spreading the word. Even standard textbooks on TEM do not get it right. I have been made to feel that I am a failure.

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