PREFACE

New possibilities with aberration-corrected electron microscopy

Unlike light microscopy, where resolution is diffraction limited, the achievable resolution of electron microscopes is limited by lens aberrations so severe that the practical resolution is orders of magnitude worse than the diffraction limit. About 10 years ago, the first practical electron lens spherical aberration correctors were developed, and in the past decade, their performance, versatility and practical usefulness have been steadily improved. Commercial aberration-corrected instruments are available, and experiments previously deemed impossible are now being undertaken.

It can reasonably be argued that aberration-corrected microscopy is now moving from the development stage to the application stage, and it was therefore timely to bring together the leading exponents in the field for a 2-day Discussion Meeting, hosted by the Royal Society, in London in November 2008, to discuss these recent developments and applications, and to look to the future. Invited papers presented at that meeting are contained in this issue.

The Discussion Meeting, attended by over 130 participants, opened with a session on the history (Hawkes 2009) and development of aberration correction and correctors. Haider (2009), Krivanek et al. (2009) and Zach (2009), three of the pioneers in the development and commercialization of correctors, gave papers describing the current state of instrumentation. Krivanek et al. (2009) tackled the problem of chromatic aberration by discussing monochromation and the possibility of incorporating a chromatic aberration corrector into a monochromator, while Haider (2009) and Zach (2009) considered advanced corrector designs including the correction of chromatic aberration.

The second session comprised four papers reporting experimental results obtained with the new instrumentation. Pennycook et al. (2009) demonstrated the power of aberration-corrected scanning transmission electron microscopy (STEM) for solving materials problems at the atomic level of resolution, while Urban et al. (2009) described the value of being able to tune spherical aberration to optimize the information available from aberration-corrected transmission electron microscopy (TEM). Improving resolution and quantification by the combination of a set of images taken at different focus and illumination tilt settings in an aberration-corrected environment was the theme of the contribution presented by Kirkland (Haigh et al. 2009). Gabor’s dream of electron holography...
has been brought to reality by a number of groups, but none better than that of Lichte et al. (2009), who reported developments in electron holography with aberration correction.

The cost and versatility of modern electron microscopes are causing the field to form consortia to achieve not only the necessary funding, but also optimization of use. In the USA, a major grouping has an ambitious 5-year programme (TEAM) that will culminate in an instrument fitted with spherical aberration correctors both pre- and post-specimen, a post-specimen chromatic aberration corrector, a monochromator, a new high-brightness gun and a novel specimen stage. The current state of this project was reported by Dahmen et al. (2009).

Rose (2009), who inspired and led the subject of aberration correction for decades, presented his ideas on the necessary developments to further advance the subject, and this theme of future possibilities was taken up by Nellist in outlining ideas for three-dimensional imaging by confocal microscopy, made possible by the reduced depth of focus achievable in an aberration-corrected system (Behan et al. 2009). Colliex et al. (2009) described particular methods of data handling in STEM, looking forward to their application in an aberration-corrected instrument.

The unenviable task of summarizing the presentations and looking forward was admirably handled by Howie (2009), whose paper provides a succinct and perceptive foresight, nicely matching the historical paper by Hawkes (2009), which acts as the other book end to this Discussion Meeting Issue.

In addition to these invited papers, there were eight invited posters, each with a 5 min presentation, followed by a lively poster session. Those are not included in this issue, but their presenters (Muller, Boothroyd, Gai, Snoeck, Kaiser, Tanaka, Watanabe and Zhu, together with a poster from Walther) are thanked for their contributions.

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References


