



Wolfprize Winners Maximilian Haider, Harald Rose and Knut Urban

Wolfprize in Physics 2011

A Breakthrough in Electron Microscopy with Hardware Aberration Correction

May 29, 2011 - The electron microscope is one of the most widely used research tools in modern science, playing a pivotal role in virtually all areas of natural sciences, as well as in a broad range of technologies, from basic research to vital industries.

Since its invention in 1931, the performance of electron microscopy has been limited by the effects of the aberrations of the electron lenses used, which kept its spatial resolving power at values far below the theoretical limit. Given its broad role in advancing modern science and technology, extraordinary efforts were made, worldwide, to overcome these limitations. But, for over half a century, these attempts failed.

Working together since 1990, the three Wolf Prize Laureates jointly succeeded in realizing aberration-corrected electron optics for the first time. As a result, they have advanced the resolution of transmission electron microscopy to atomic and sub-atomic dimensions. Their work was inspired by a novel optical concept for the correction of spherical aberration of the objective lens of an electron microscope, developed by Harald Rose (born 1935, Germany). Based on this corrector principle, Maximilian Haider (born 1950, Austria) constructed the first prototypical aberration-corrected transmission electron microscope. Knut Urban (born 1941, Germany) developed this prototype into a working platform for atomic-resolution elec-

tron microscopy. He also developed the theoretical and methodological basis for extending and interpreting microscopy in sub-atomic dimensions.

For the first time, aberration-corrected transmission electron microscopy has permitted localization of atoms with an accuracy of a picometer, corresponding to one hundredth the size of a hydrogen atom. The ability to measure individual atomic positions with picometer precision and to correlate atomic-scale structure with macroscopic physical properties constitutes a major breakthrough in materials science, with implications for many other areas of science and technology. The breakthrough in exploring the microcosm comes at a time when developing nanotechnologies and getting them to work for a number of applications, calls for high-resolution, high-sensitivity instrumentation for research, synthesis and validation of novel techniques.

Within less than five years since the commercialization of aberration-corrected electron microscopy, more than 200 of these instruments have been ordered by university and industrial research laboratories all over the world, pointing to the central role that state-of-the-art electron microscopy plays in 21st century research and putting an end to decades of stagnation in this key area

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Text originally published by Wolf Foundation, Winners 2011 in Physics, online at: <http://www.wolffund.org.il/index.php?dir=site&page=winners&name=&prize=3016&year=2011&field=3008>