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Advanced Electron Microscopy and Spectroscopy for Materials Research and Development

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Electron microscopy/spectroscopy is one of the most critical tools enabling many advancements in science and technology. “Seeing is believing” is literary a fundamental basis for scientists to find evidence to explain how nature works. A quest to “know and look” further and further into more details of the nanoworld is a motivation to develop better resolution transmission electron microscopes. Insight into the atomic world in the level of pico-meter reveals an un-imaginable nature of materials and their functionalities. In 1931, Ernst Ruska, a German physicist and Max Knoll, an engineer, were the first to successfully build a transmission electron microscope (TEM). It was not until 1986 that Ernst Ruska received a Noble Prize in Physics for his work in electron optics. Nonetheless, it was recognition to an inventor of an important scientific tool.

The resolution of TEMs is limited primarily by two factors: the wavelength of the incident electron and the spherical aberration (C_s) of the objective lens, which is a property of the lens itself. For over 50 years, major effort to improve TEM image resolution was put over using shorter and shorter wavelength (higher and higher accelerating voltage). There was a TEM in Osaka, Japan, that can go as high as 3 million eV. Not until the last twenty years when the drive to improve the resolution was seriously shifted to improve the other factor: reducing spherical aberration of the electromagnetic lens. Currently, resolution of 0.05 nanometer (5 pico-meter) is achievable. This presentation will review and discuss the development of C_s corrected TEM and it applications.