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A 120 kV Transmission Electron Microscope Series for Both Life Science and Material Science Fields

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Observation by transmission electron microscopes (TEM) utilizing low acceleration voltage is widely used for the analysis of light-element materials and low contrast samples in various fields. To address these needs and more, the Hitachi HT7800 series was developed. This revolutionary new TEM series consists of two models which have been designed for primary use in biological as well as nano-science fields. Both models incorporate a high speed CMOS navigation camera which enables rapid and efficient specimen searching as well as increased ergonomics, low-dose viewing, and high-throughput analyses. The newly developed user interface and functionalities including *Image Navigation* allow for intuitive operation and enhanced imaging. In addition, the incorporation of additional automated functions make it possible to capture images at user-defined locations via a low-magnification grid overview image.

Furthermore for the HT7800 series, a multi-purpose pole piece was developed for instances where both material science and life science optimized imaging is needed with a single instrument. Table 1 shows a line-up of options for the HT7800 series. The standard (STD) lens and the ultra-high resolution (UHR) lens are designed for optimized conditions in life science and materials science respective applications. [1] By employing a technique deemed “nano-analysis function”, selected-area electron beam diffraction (SAED) patterns can be acquired automatically at multiple positions pre-designated by an operator. [2] Thereafter, the “diffraction analysis function” of Hitachi EMIP software is capable of automatic measurement for the acquired diffraction spot intervals with interpretation of crystal structure and material analysis from a database.

Additionally, all models of the HT7800 series employ a dual mode objective lens that consists of two lenses; a main lens and mini-lens that allow for alteration of focal length with a simple click - no hardware changes need be made. Switching between imaging modes for high contrast and high resolution is quick, simple, and consistent.

Figure 1 shows the concept of the dual mode objective lens where a double-gap magnetic path is employed. When the mini lens is excited at reversed polarity to the upper lens polarity, the focal length is shortened without changing the specimen Z-position allowing for a higher resolution image to be obtained. However, when the mini lens is excited with the same polarity as the upper lens, the focal length is longer and allows for higher contrast imaging conditions. Since the heat effect is the not altered when the polarity of mini-lens is changed, thermal drift of a samples is negligible when changing modes allowing for high throughput and efficient data acquisition.

An example of a high resolution TEM image with the multipurpose configuration is shown in Fig.2. Lattice of the TiO_2 nanoparticles is clearly observed at an accelerating voltage of 120 kV with the optical mode of the objective lens set to HR. Further detail of instrument and application results will be provided.

References:
[1] Tamura K. *et. al*, Microsc. Microanal. **23 (Suppl 1)** (2017), p. 62.
[2] Kamino T. *et. al*, Proc. of IMC 18, Prague, Czech Republic (2014) IT-6-P-1552.

Table 1. Line-up of objective lenses for HT7800 series

Item	STD lens	Multipurpose lens	UHR lens
Resolution (lattice)	0.204 nm@120kV	0.14 nm@120 kV	0.14 nm@120 kV 0.19 nm@120 kV (on-axis)
Magnification	x50～x600,000	x50～x800,000	x100～x1,000,000
Camera length	0.2 ～ 5.0 m	0.2 ～ 5.0 m	0.05 ～ 2.0 m

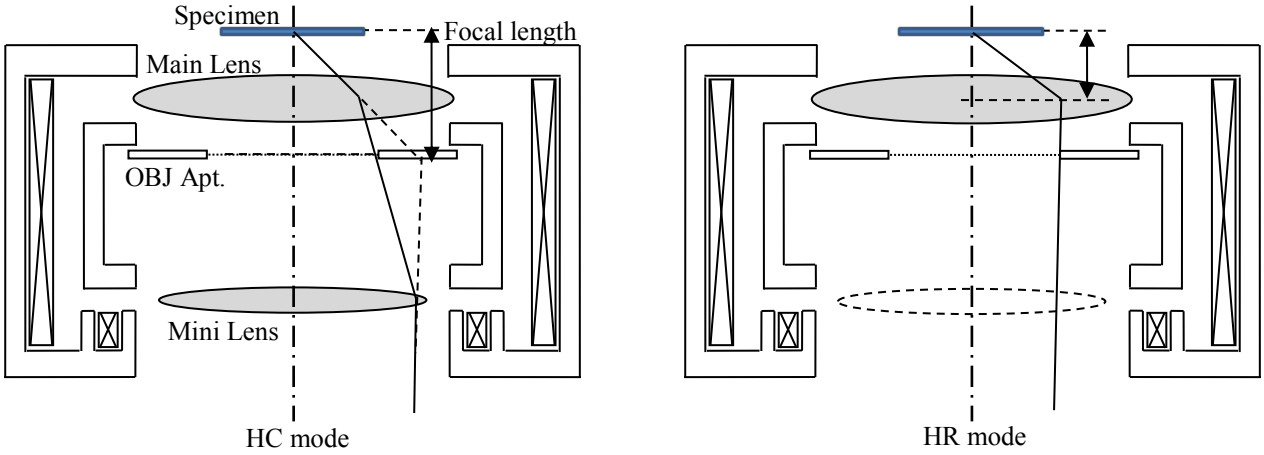

Figure 1. Schematic diagrams of two image forming optical systems (HC mode & HR mode) for the dual mode objective lens.

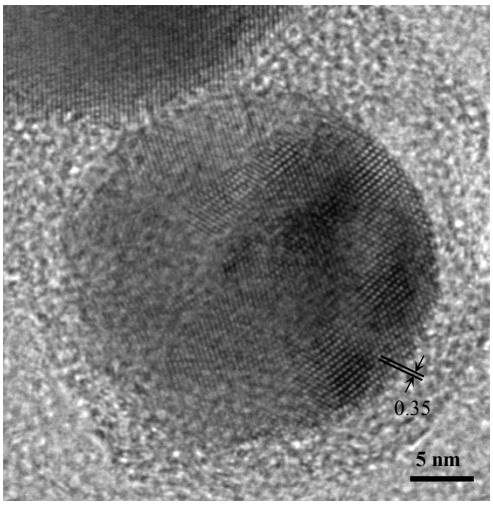

Figure 2. TEM image with multipurpose configuration: TiO2 nanoparticles (Vacc: 120 kV, HR).

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