電解放出形走査型電子顕微鏡
Field Emission Scanning Electron Microscope (FE-SEM)

基本仕様 / Specifications

日立ハイテクノロジーズ（Hitachi High-Technologies）SU6600

- **加速電圧 / Acceleration Voltage : 0.5 - 30kV**
- **二次電子分解能 / Secondary electron resolution**
  - **高真空モード / High vacuum mode : 1.2nm（30kV）、3.0nm（1kV）**
  - **低真空モード / Low vacuum mode（150Pa）: 4.5nm（30kV）**
- **反射電子分解能 / Backscattered electron resolution : 3.0nm （30kV、低真空（10Pa））**
- **エネルギー分散型X線分析装置搭載 / Come with Energy dispersive X-ray spectroscopy (EDX)**
- **透過電子観察（STEM）用検出器あり / Come with STEM**

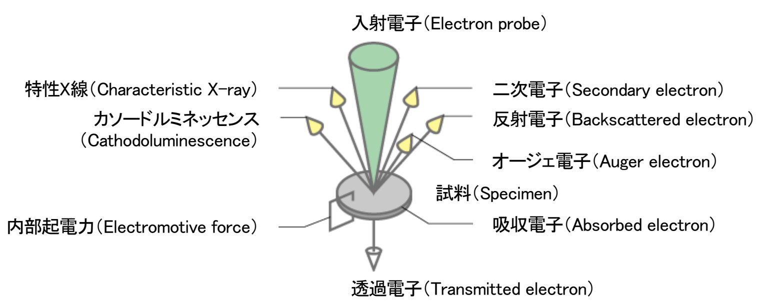


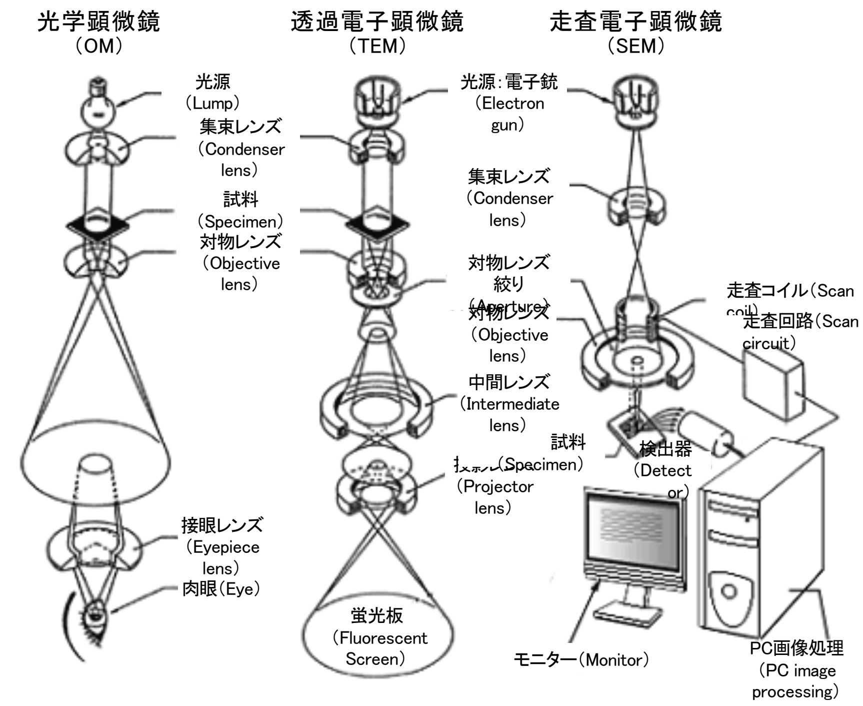
Fig. 1 試料から得られる情報(Information obtained from specimen)

走査電子顕微鏡（SEM）は、光学顕微鏡では観察不可能な微小な表面構造を鮮明に観察することができます。さらに、焦点深度が深い像が得られることから、凹凸の激しい試料表面の構造を拡大して、私達が肉眼で物を見るのと同じような感覚で、三次元的な画像が観察できる装置です。

TEMでは、薄い試料を透過した（通り抜けた）電子線を蛍光面に衝突させ、その試料の拡大像を見ているのに対して、SEMの場合は、試料の表面に電子をあてて、そこから反射、または発生してくる電子（主に二次電子）を検出して像を見ています。二次電子は電子プローブが試料表面に入射する際の角度によって発生強度が変わるために試料表面の 微細な凹凸を二次電子の強弱として検出し表すことができます。

さらに、エネルギー分散型X線分析装置（EDX）で特性X線を検出することにより、試料を構成する元素と濃度を調べることができます。

基本原理 / Mechanism



	OM	TEM	SEM
分解能(Resolution)	200nm	0.1nm	0.5nm
倍率(Magnification)	～×2000	×50 ～ 1,500,000	×10 ～ 1,000,000

The Scanning Electron Microscope (SEM) enables a clear observation of very small surface structures, which is not possible with an optical microscope. Moreover, as it can provide images with deeper focal depth, it enables observations of 3-dimensional images, with a similar sense as when we look at a substance with the naked-eye, by enlarging the specimen surface which has a rough structure.

TEM provides an enlarged image projected onto a fluorescent screen, where the image is formed by the electrons transmitted (passed) through the thinly prepared specimen. In comparison, SEM forms the image using the electrons (secondary electron in general) which were reflected or generated from the surface of the specimen. As the intensity of the generated secondary electrons varies depending on the angle of the incident electrons onto the specimen surface, subtle variations in the roughness of the surface can be expressed according to the signal intensity.

Furthermore, it is also possible to investigate the element and density of samples by analyzing characteristic X-ray which is detected by using energy dispersive X-ray spectroscopy (EDX).

https://www.jeol.co.jp/science/sem.html

実用例 / Application Examples

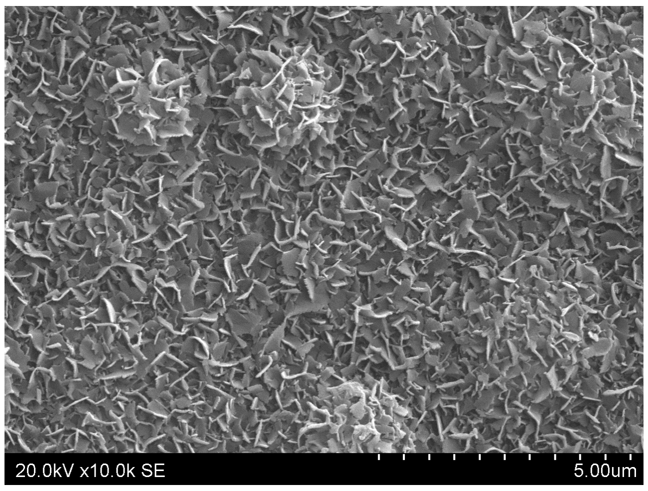


Figure 1. FE-SEM micrograph of the surface of bioactive polymeric bone implant spontaneously covered with flake-like crystallites of hydroxyapatite, which is a main component of bone tissue, in simulated body environment.

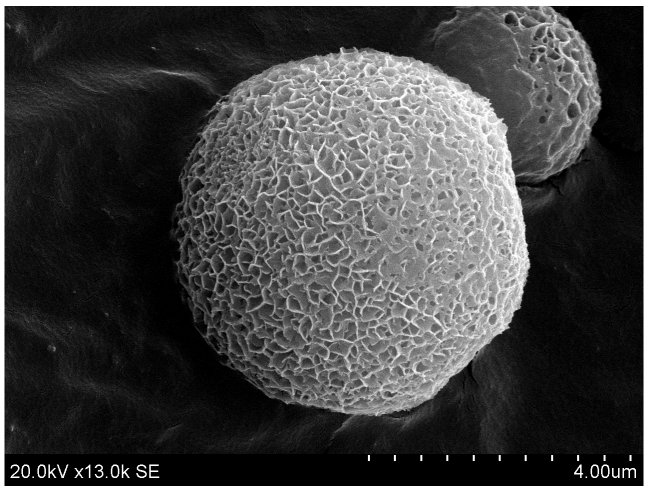


Figure 2. FE-SEM micrograph of microcapsules consisted of flake-like crystallites of hydroxyapatite formed in simulated body environment.

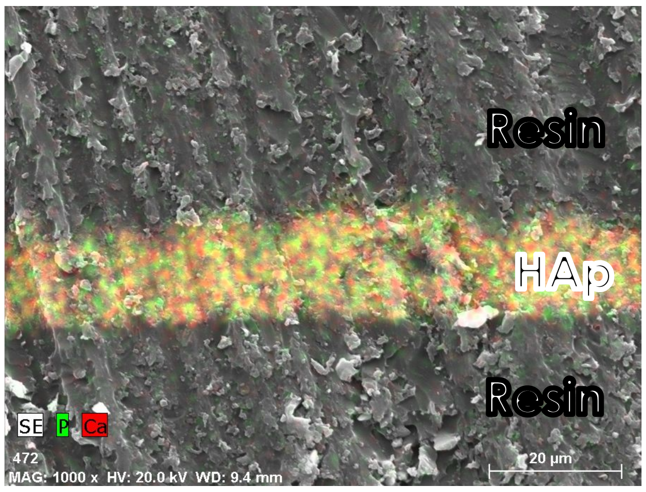


Figure 3. FE-SEM and EDX mapping integrated image of cross-section of self-supported thin film consisted of hydroxyapatite (HAp; $Ca_{10}(PO_4)_6(OH)_2$) formed in simulated body environment.

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