電界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 (Hitachi High-Tech) SU6600

- **加速電圧 / Acceleration Voltage : 0.5 ~ 30 kV**
- **二次電子分解能 / Secondary electron resolution**
  - **高真空モード / High vacuum mode : 1.2 nm (30 kV), 3.0 nm (1 kV)**
  - **低真空モード / Low vacuum mode (150 Pa) : 4.5 nm (30 kV)**
- **反射電子分解能 / Backscattered electron resolution : 3.0 nm (30 kV, 低真空 (10 Pa))**
- **エネルギー分散型X線分析装置搭載 / Energy dispersive X-ray spectrometer (EDX) XFlash® 5010, Bruker**
- **電子後方散乱回折装置搭載 / Electron backscatter diffractometer (EBSD) C-Nano+, Oxford Instruments**

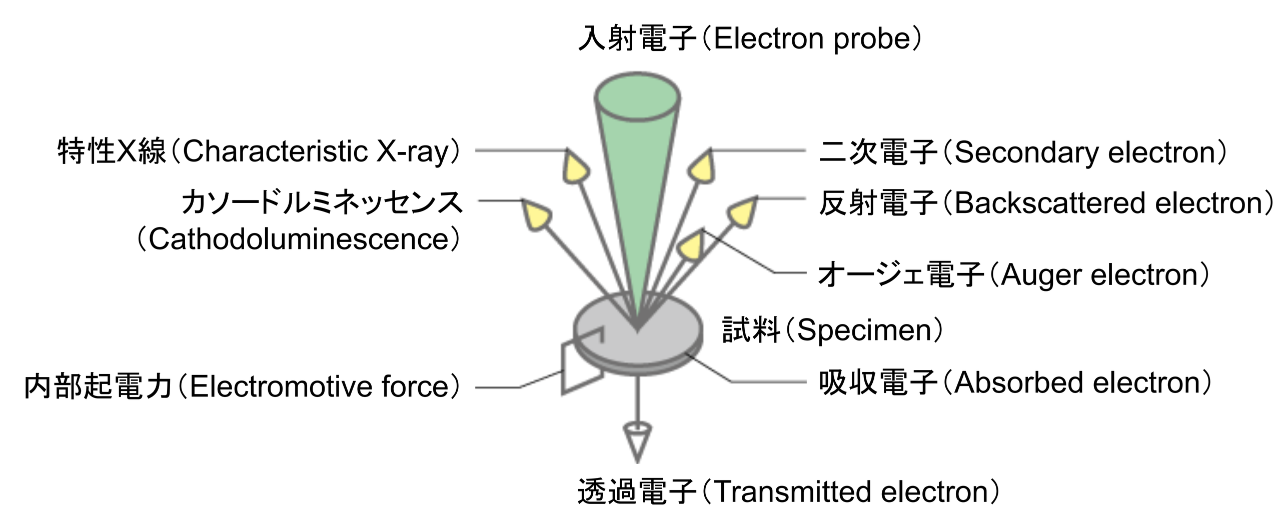


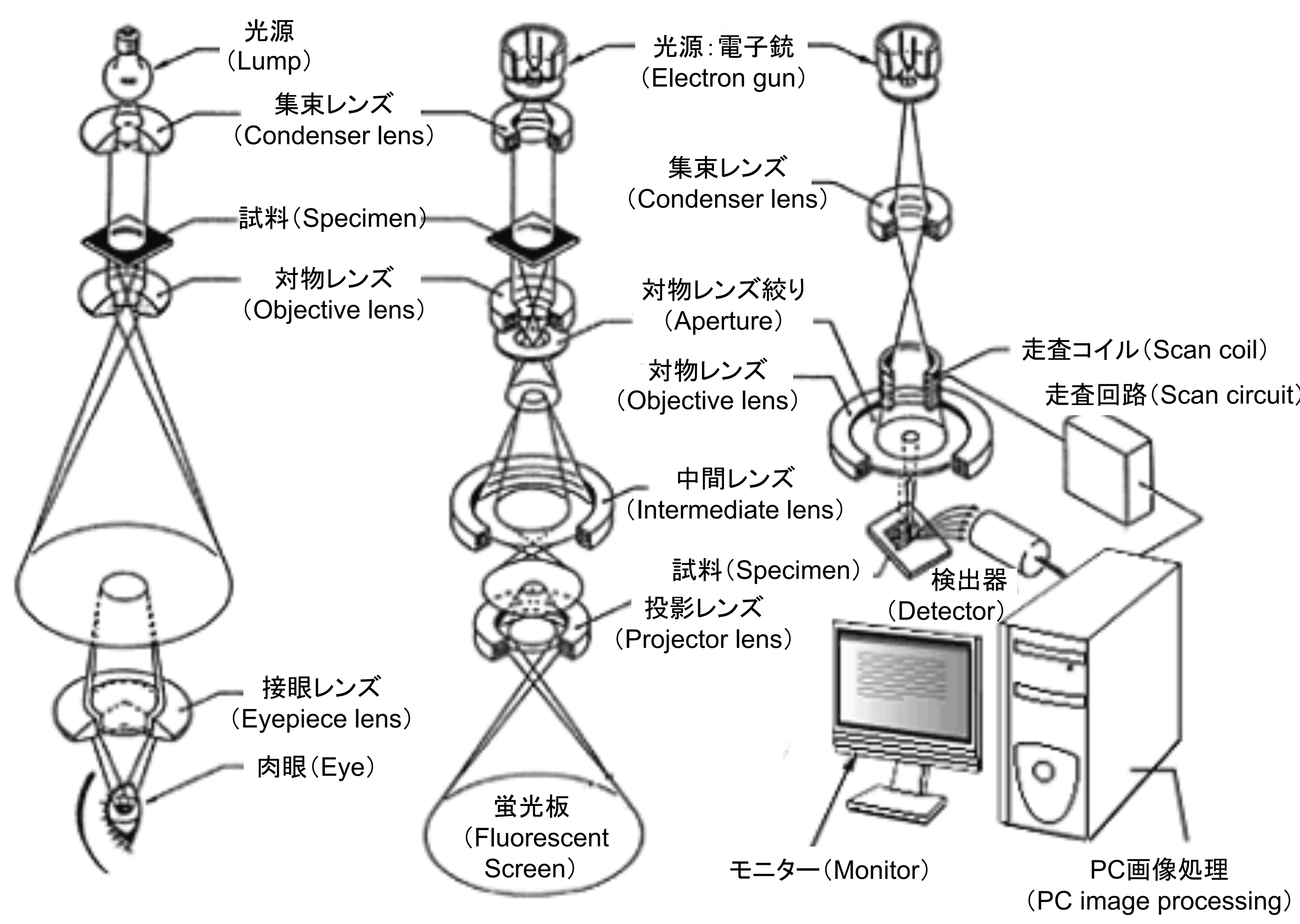
Fig. 1 試料から得られる情報（Information obtained from specimen）

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。

SEM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。

また、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。さらに、電子後方散乱回折装置（EBSD）により、試料表面近傍の結晶構造および結晶配向に特有な電子線回折パターンを検出することで、試料の微細構造に関する結晶系の情報を得ることができます。

基本原理 / Mechanism



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

Scanning electron microscopy (SEM) enables the precise observation of microscopic surface structures, which is impossible with an optical microscope. Moreover, as it can provide images with deeper focal depths, it enables the observation of three-dimensional images, similar to observing a substance with the naked eye, by enlarging the specimen surface, which has a rough structure.

SEM forms an image by using electrons (secondary electrons in general) that are reflected or generated from the surface of the specimen. Because the intensity of the generated secondary electrons varies depending on the angle of the incident electrons on the specimen surface, subtle variations in the roughness of the surface can be expressed according to the signal intensity.

In addition, elemental information can be obtained by analyzing characteristic X-rays, which are detected using energy-dispersive X-ray spectroscopy (EDX). Furthermore, electron backscatter diffraction (EBSD) can detect the diffraction patterns of electron beams that are specific to the crystal structure and orientation near the sample surface, thereby providing crystallographic information regarding the sample microstructure.

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

実用例 / Application Examples

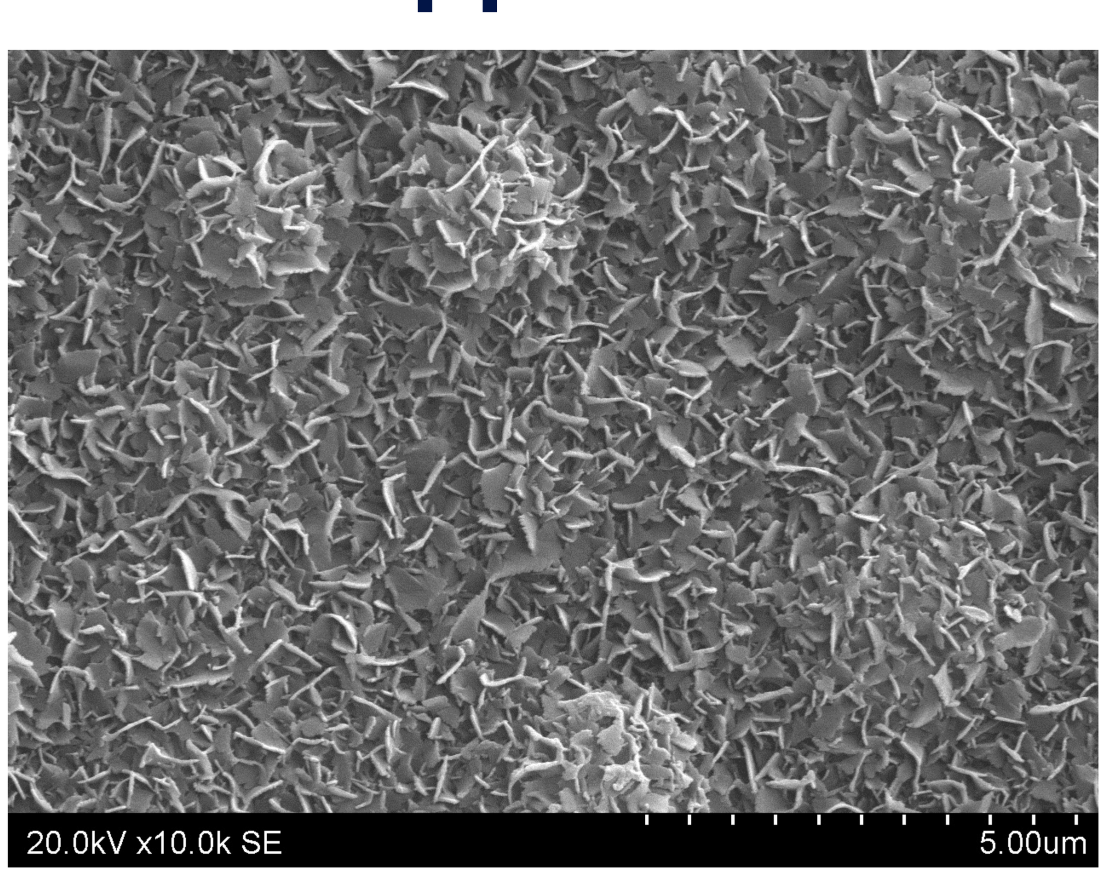


Figure 1. FE-SEM micrograph of the surface of bioactive polymeric bone implant spontaneously covered with flake-like crystallites of hydroxyapatite, which is a main component of bone tissue, in simulated body environment.

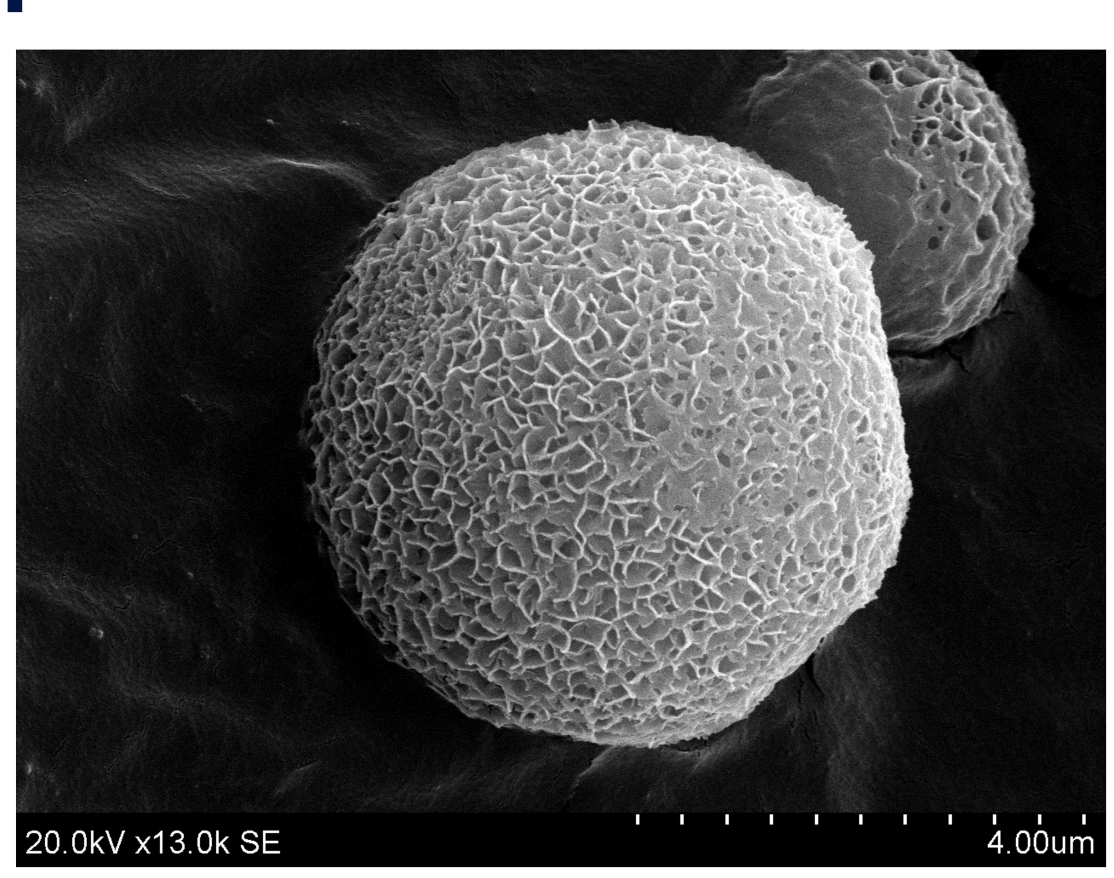


Figure 2. FE-SEM micrograph of microcapsules consisted of flake-like crystallites of hydroxyapatite formed in simulated body environment.

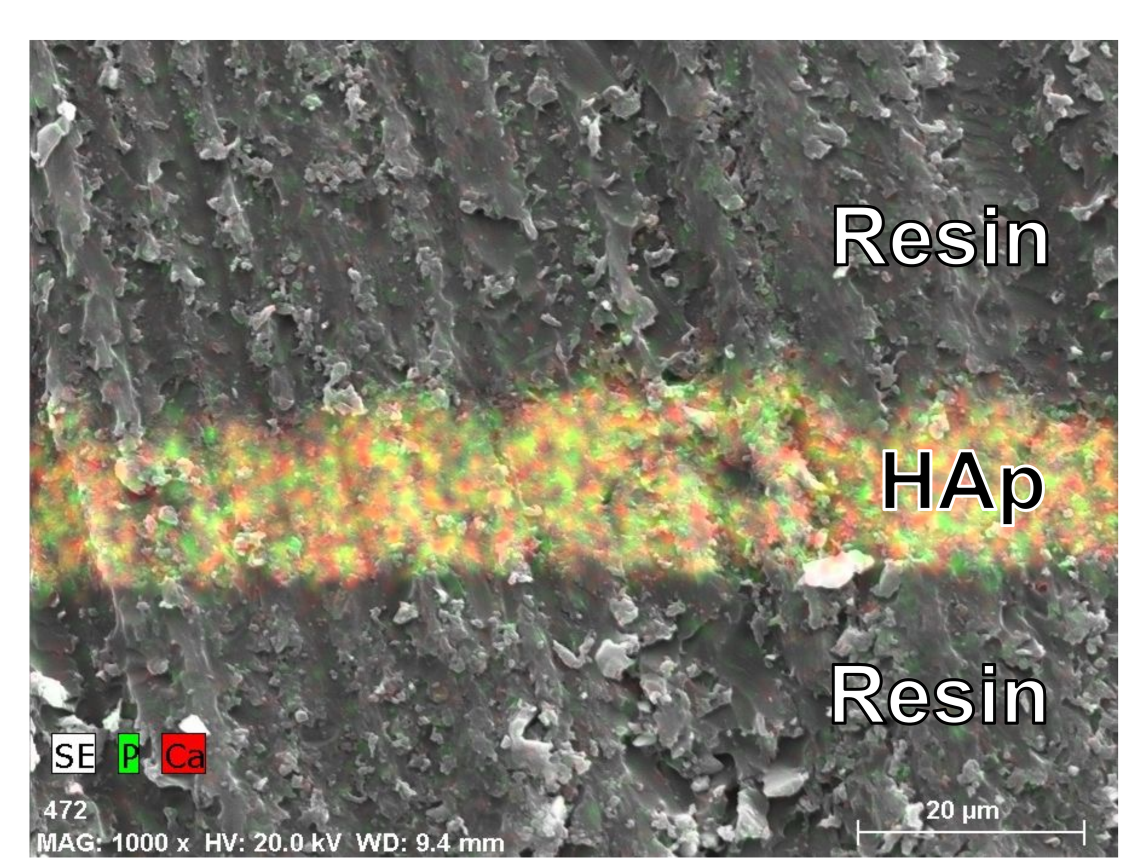


Figure 3. FE-SEM and EDX mapping integrated image of cross-section of self-supported thin film consisted of hydroxyapatite (HAp; $Ca_{10}(PO_4)_6(OH)_2$) formed in simulated body environment.

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