

## **RESEARCH LABORATORY**

FOR DENTAL BIOMATERIALS



Friedrich-Alexander-Universität Faculty of Medicine



# Microscopy



• Uses a system of lenses and visible light to illuminate and provide a close-up view of



 (Left): Stereomicroscope with exchangeable lenses with attached digital camera and external

- objects, revealing structural and topographical details out of reach to the naked eye.
- Usually refers to microscopes in which the image is rendered purely by the lens system and not otherwise processed by a computer program (digital microscopy).
- In most current light and stereo microscopes, a mirror system allows the feeding into a digital camera, which then separately digitises the image into a processing software.

#### light sources.

- (Right): Micrograph of a thin slice of human enamel under polarised light revealing different prism orientations.
- (Left): Composed image of different wavelength emissions in a demineralised human enamel layer.
- (Right): 3-D reconstruction of a dentin substrate infiltrated with dyed dentin adhesive showing penetration into the dentinal tubuli.



## Confocal Laser Scanning Microscopy

- Refers to an imaging technique that uses one or several Laser beams of different wavelengths to illuminate the sample at a very narrow focal plane.
- It is often combined with an optical microscope used in different modes; the automated to focus allows for the stage to be moved to successive confocal planes.
- The samples are usually dyed with fluorescent molecules that emit light in the wavelength excited by the laser, commonly used for biological tissues.





Microscopes that utilize physical lenses for image acquisition but forego ocular



objectives, rendering images that are automatically digitised.

- Modern digital microscopes are fully operated through a digital interface, such a thorough touch-pads and joysticks, while programmable tasks are fully automated.
- Electronic features, such as automated x-y-z tables and swing arms allow for two- and three-dimensional mapping and reconstruction of surface topography.

 (Right): Micrograph of a Li<sub>2</sub>O-2SiO<sub>2</sub>
 glass-ceramic with bulk crystallization of Li<sub>2</sub>Si<sub>2</sub>O<sub>5</sub> crystals.

- (Left): White light profilometer with automatic x-y stage and two lenses for detection in millimeter range with nanometer resolution.
- (Right): 3-D
  reconstruction of an
  abraded dental crown.
- Micrographs of etched human enamel (left) and dentin (right) under the SEM showing the surface patterns after demineralization with

### **Non-contact Profilometry**

- Uses confocal white light sensors to create two-dimensional height profiles and threedimensional topographical maps for advances surface metrology applications.
- Works on the principle of white light interferometry to obtain data of x, y, z coordinates of each surface point.
- With a resolution down to a few nanometers, it finds use for accurate surface metrology and measurements of volumetric change when compared to a reference.

**Scanning Electron Microscopy** 

Is based on the bombardment of a sample by a focused beam of electrons, which interact with atoms at the volume of the sample giving different signals.





• The most common interactions yield secondary electrons and elastic back-scattered electrons and X-ray emission, the latter allowing for atomic characterization.

Since the sample has to conduct electrons, the metallisation of the sample's surface is usually the preferred preparation method (such as with gold, palladium, carbon etc.).

phosphoric acid (35%). Prismatic contours are revealed in enamel and collagen fibres in dentin.



- Is the technique of fracture surface analysis used in forensic engineering aimed to assess crack paths, surface markings, stress states in the piece and failure origins.
- Relies on the ability of a trained forensic fractographer to ,,read" the fracture surface and identify fractographic features that give information on fracture events.
- Uses complementary microscopy techniques such as optical microscopy, surface metrology, scanning electron microscopy so to reach a failure diagnosis.



 Composition of images using optical- and MEVmicrographs used to illustrate the fracture surface of a in-vivo fracture dental crown. Both techniques offer complementary information that is used to understand the fracture event and trace back the fracture origin.