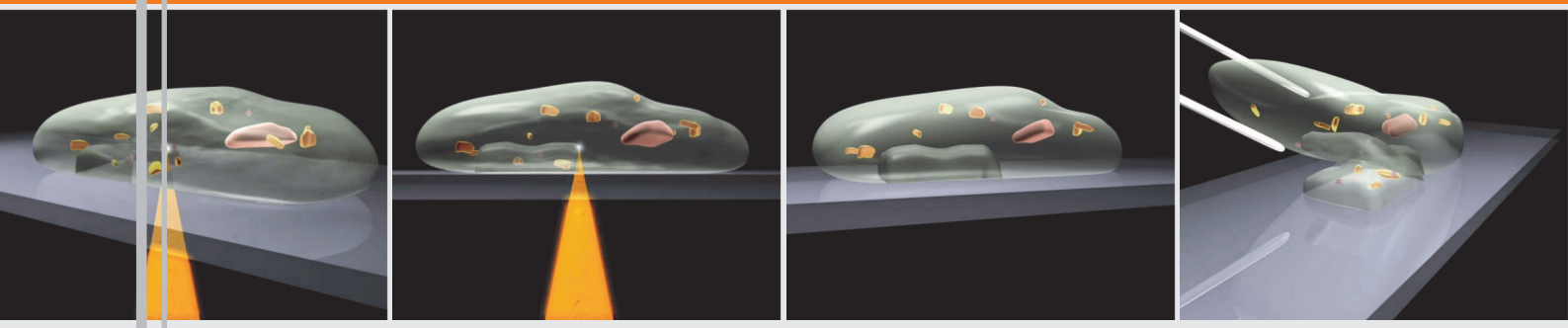
ROWIAK
photons at work

LMT F14

Cut in Three Dimensions



The Rowiak Laser Microtome: 3-D Cutting and Imaging

The Next Generation of Microtomes

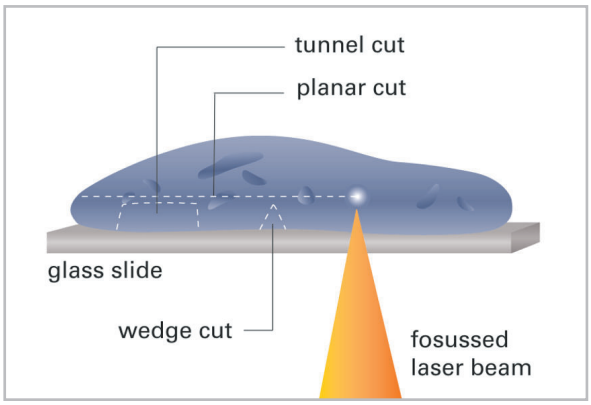
LMT F14 - Non-contact laser microtomy

The Rowiak laser microtome LMT F14 is a multi-purpose instrument designed for sectioning, microstructuring and imaging of biological tissue and various materials. Femtosecond laser technology is the key for this novel generation of microtomes. Ultrafast laser pulses enable precise, non-contact processing of specimens. A main advantage of the laser microtome is its ability to cut native tissue as well as hard tissue without decalcification. The LMT F14 is optionally available with a Navigation Modul. This tool is based on Optical Coherence Tomography (OCT), a three-dimensional imaging technology. The unique combination of laser microtomy and OCT imaging allows 3-D navigated cutting, making the LMT F14 suitable for a wide range of applications in life sciences and materials research.

LMT F14, stand-alone version (also available as table -top system)

Cutting-edge laser technology

Main component of the LMT F14 is a NIR femtosecond laser. Near-infrared radiation is well suited for processing biological material, because most biological tissues have a very low absorption coefficient for this part of the spectrum. Thus specimens can even be manipulated inside. To perform a cut the laser beam is tightly focussed into the specimen by a high numerical aperture objective. Because of the very high photon density inside the laser focus, non-linear optical processes are induced, which finally lead to ablation. But this effect is only limited to the very small focal volume, thus allowing cuts with micrometer precision.



Principle of laser microtomy: The focussed laser beam penetrates the tissue and performs a cut.

Sectioning and 3-D cutting

To prepare tissue sections the laser beam and the specimen are moved simultaneously - the laser beam by a fast scanner and the specimen by a three-axis piezo-driven positioning stage. Depending on the material being processed slice thicknesses of 7 to 100 µm are feasible. The method is not only suited to prepare thin slices but 3-D sections as well.

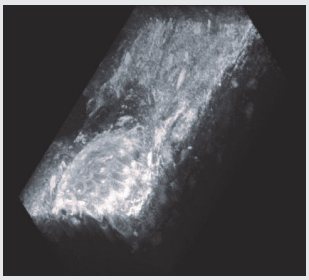
Navigation Module: See What You Cut!

OCT-navigated cutting

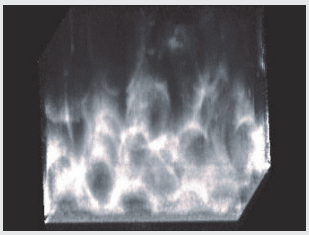
The LMT F14 is optionally available with a Navigation Module for three-dimensional imaging of specimens. This add-on module is based on Optical Coherence Tomography (OCT) and enables 3-D navigated cutting. Laser microtomy with integrated OCT imaging technology provides a unique combination of three-dimensional imaging and cutting, facilitating analysis and dissection of samples.

A powerful combination

The Navigate Module gives full control of cutting processes. It assists to predefine cutting geometries, to assess the cutting quality or to measure distances. Applications include controlled sectioning of biological tissues as well as cutting along predefined structures or even cell layers. OCT imaging is also suited to visualize the inner structure of different materials. This makes the LMT F14 with Navigation Module perfect for materials research. It can be used to identify regions of interest and to cut material samples.



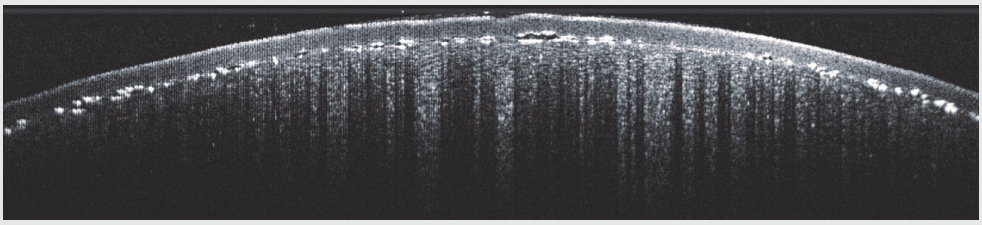
3-D OCT image of a kiwi fruit section.



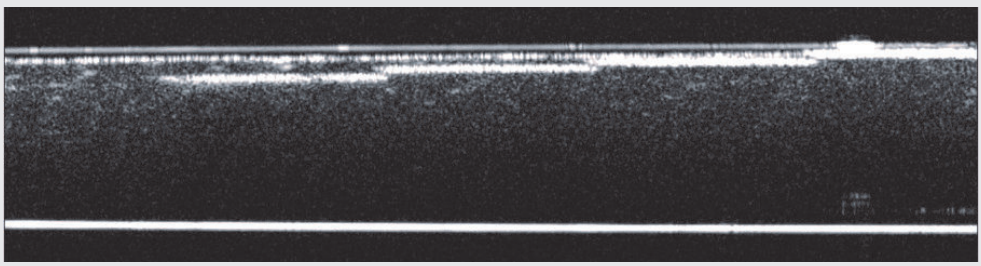
3-D OCT image of a ceramic scaffold for tissue engineering.

Technical details

The Navigation Module is equipped with a Spectral Radar OCT imaging system and an additional OCT-module containing the reference arm and optics for dispersion compensation. Based on a NIR laser the OCT system allows for deep penetration of biological tissues. A piezo-driven three–axis positioning stage enables 3-D imaging and cutting.



Porcine cornea. The cut was placed directly under the epithelium



Cascaded cut inside Teflon.

Versatile Applications

Sectioning, 3-D cutting and structuring

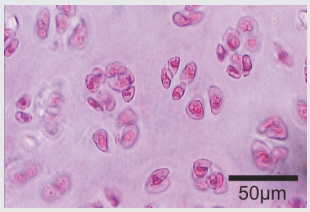
The LMT F14 is suitable for processing biological tissue as well as materials, such as ceramics, polymers and resins. It can be used to prepare thin tissue sections for microscopic examinations or to obtain cell material for the purpose of cultivation. The laser microtome is also ideal for microstructuring. Scaffolds for tissue engineering, for example, can easily be modified to support the cell growth. However, in combination with the Navigation Module the LMT F14 does not only allow for two-dimensional sectioning but also for three-dimensional cutting. This provides great flexibility and enables novel applications.

No time-consuming tissue preparation

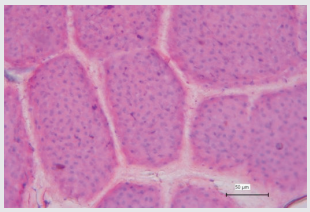
A cost and time saving benefit of the laser microtome is the ability to slice different biological tissues in their native states. Extensive and time-consuming sample preparation techniques are not required. In particular, the LMT F14 is an optimal solution for sectioning tissue which is sensitive to chemical fixation. The gentle and contact-free cutting method prevents tissue damage and contamination. Even sectioning of hard tissues such as bone and tooth is feasible without decalcification.

Applications - overview

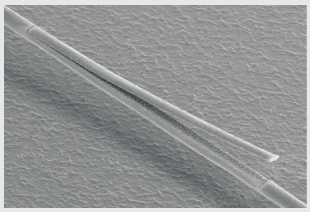
- sectioning of native tissue samples
- sectioning of hard tissue samples
- cutting of predefined areas
- cutting and microstructuring of materials
- three-dimensional processing and imaging



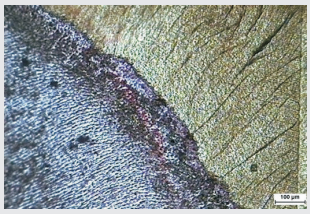
Porcine hyaline cartilage section, taken from native tissue.



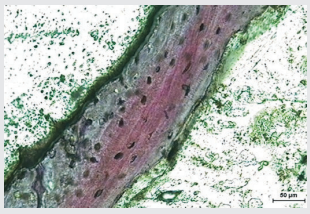
Porcine skin section, taken from native tissue.



SEM image of a human hair. Laser microtomy leaves the inner structures intact.

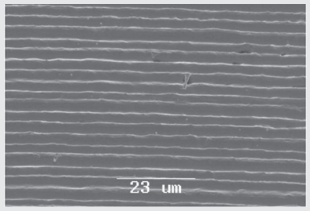


Bovine tooth section, not decalificated.



Porcine bone section, not decalcificated.

Sectioning of small Teflon blocks.



SEM image of a microstructured Teflon sample.

Easy to Use Software

Intuitive graphical user interface

The LMT F14 software provides an easy to use, intuitive graphical user interface. The software includes functions for sectioning, three-dimensional cutting and data storage. It also includes distance-measurement tools and different imaging features.

Laser cutting

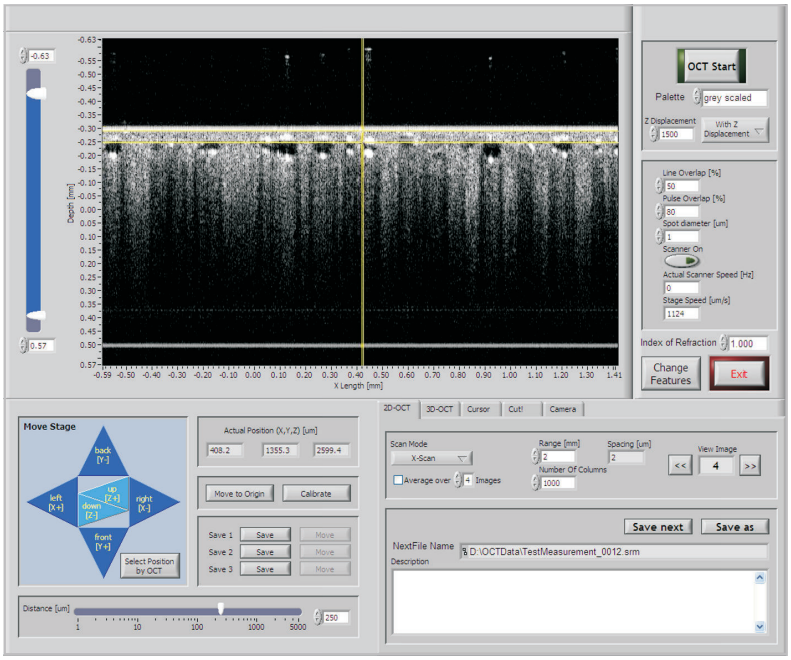
The average laser power can be adjusted to match the different types of specimens. Cutting parameters such as scanner speed or stage speed can be changed as well. Different cutting modi enable two- and three-dimensional sectioning. A freehand tool allows for various user-defined 3-D cutting geometries. The software can be upgraded with additional predefined cutting procedures.

OCT imaging

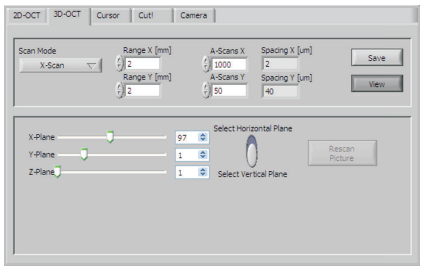
OCT imaging facilitates the navigation within the sample volume and assists to find cutting coordinates or take measurement. The software is able to generate 3-D OCT images. These images can be used to analyse the inner structure of samples or to check the quality of three-dimensional cuts.

Control and safety

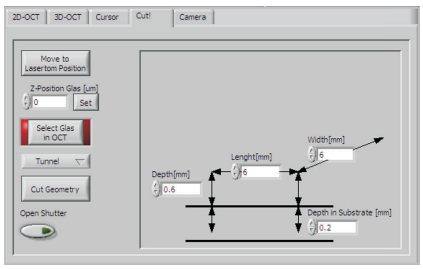
An integrated camera allows for positioning of specimens and for online-monitoring of cutting processes. If necessary, the cutting process can be interrupted at any time. In this case the laser shutter closes automatically.



Two-dimensional OCT imaging. The horizontal yellow line marks the cut.



Parameter setting for 3-D OCT imaging.



Parameter setting for 3-D cutting.

LMT F14 Specifications

Design	
system versions	stand-alone or table-top
dimensions (stand-alone version)	1000 mm x 380 mm x 810 mm (Y x X x D)
weight (stand-alone version)	100 kg

Laser parameters	
laser system	solid-state femtosecond laser
average output power	2,5 W (5 W on request)
repetition rate	10 MHz
pulse duration	300 fs
wavelength	1030 nm

Positioning system	
minimum section thickness	7—10 µm
cutting speed	typically 1 mm^2/s
working area	14 x 14 mm^2 (larger on request)

OCT system	
Central wavelength	900 nm +/- 5 nm
A-scan frequency	~ 5 kHz
Optical power	~ 1.5 mW
Image speed	~ 1 fps (typically)
Image depth	max. 1.1 mm
Image size	max. 1024 x 512 px
Axial resolution	4.5 µm

The standard solution does not meet your requirements? Then please contact us! Rowiak offers customized solutions and its expertise with femtosecond laser applications.

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