



**a European Research Infrastructure for
Micro-Nano Fabrication of Functional
Structures and Devices**

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www.euminafab.eu

- “The present suite of IC-based processes and materials will not be able to meet the demands of emerging products and application areas. ...

... the **introduction of new processing technologies for new materials** and the manufacturing of miniaturised products designed with an intelligent multi-material mix will **become a top priority.**”

© adapted from The Future of Manufacturing in Europe 2015-2020
European Commission; ipts (2003)

- “**Capturing a huge amount of defect data...**

... is essential to move from R&D to production”

©Tom Cheyney, Smalltimes May/June 2007 40-41

Need to integrate European research infrastructures in micro-nano fabrication of functional structures and devices out of a knowledge-based multimaterials’ repertoire

What is EUMINAfab?



- ✪ First European Research Infrastructure for multimaterial micro and nano fabrication and characterisation
- ✪ 9 partners from 7 countries, 36 installations in micro/nano fabrication
- ✪ Transnational access is offered at no cost for public research
- ✪ EC funded (FP7) in the frame of Integrated Infrastructure Initiative
- ✪ March 2009 – February 2013, Total budget: 7.8 M€



- ✪ EUMINAfab **joins forces** of industry and academia to further exploit the unprecedented capabilities of new functional materials at the micro- and nanoscale
- ✪ EUMINAfab **opens access** to state-of-the-art processes for structuring and characterising functional materials at the micro- and nanoscale
- ✪ EUMINAfab **allows technology integration** from a wide range of disciplines, taking into account general principles of convergence and interfacing so as **to overcome fragmentation and isolation** of multimaterial micro and nano processes
- ✪ EUMINAfab **is dedicated towards facilitating industrial uptake** of emerging **multilaterals'** micro and nanotechnologies

Networking

- Virtual entry point (web-based)
- Roadmapping process
- Case studies
- Workshops
- Training
- Consultancy

Access

- Transnational access
- Open calls every six months
- Specific calls for SME
- 36 installations from 9 partner sites
- Peer review process
- Access costs are reimbursed by EC

Research

- Engineering system for multimaterial MNT
- Technology capability maps
- Technology readiness leveling & design maturity assessment
- Horizontal and vertical integration
- Validation & Demonstration

36 installations → a MNT toolbox

μ and nanostructuring

- ✚ Electron beam
- ✚ E-beam & SCIL
- ✚ Ion beam (Focused cross beam)
- ✚ DPN
- ✚ Direct X-ray litho
- ✚ Laser technologies (e.g. ps, fs, surface texturation)
- ✚ Mechanical μmachining (freeform)
- ✚ Photopolymeristn.
- ✚ Mastermaking process chain
- ✚ DRIE (Si, glass, SiO₂)

Thin film deposition

- ✚ PVD technologies (e.g. noble metals, DLC, nanocomposites, metals, nitrides)
- ✚ Sole Gel: spin and dip coating
- ✚ Org. PVD (e.g. organic liquids & powders, oxides)
- ✚ CVD (metals, polymers, ceramics)
- ✚ Self Assembly (e.g. semiconductors, organic)
- ✚ Screen printing (e.g. metals, dielectrics)
- ✚ Optical Coating

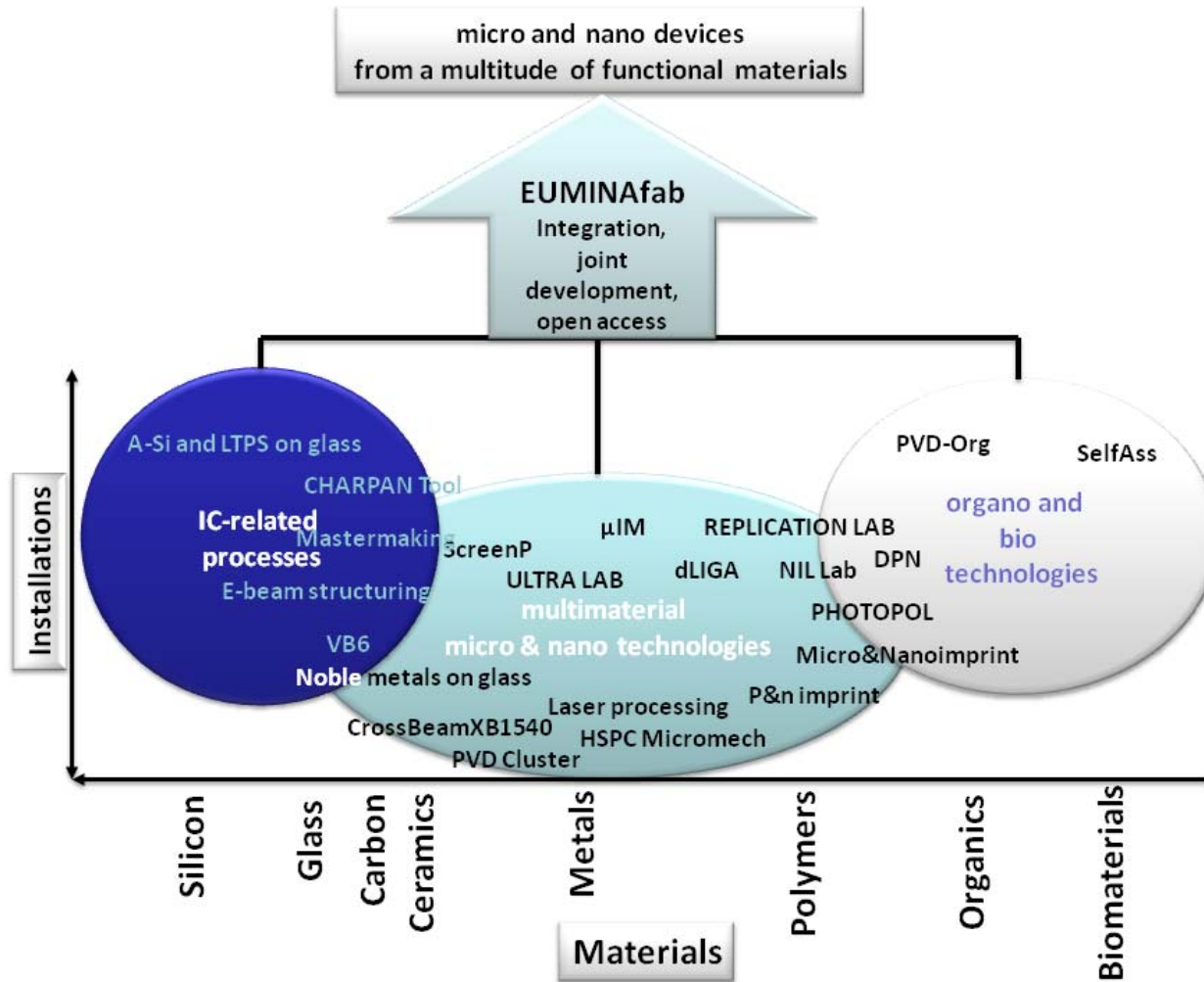
Replication

- ✚ μ injection moulding (e.g. polymers, metals, ceramics; small series)
- ✚ μ hot embossing (small series)
- ✚ Thermal imprinting & UV-NIL
- ✚ NIL process chain (UV photolitho, dry & wet etching)

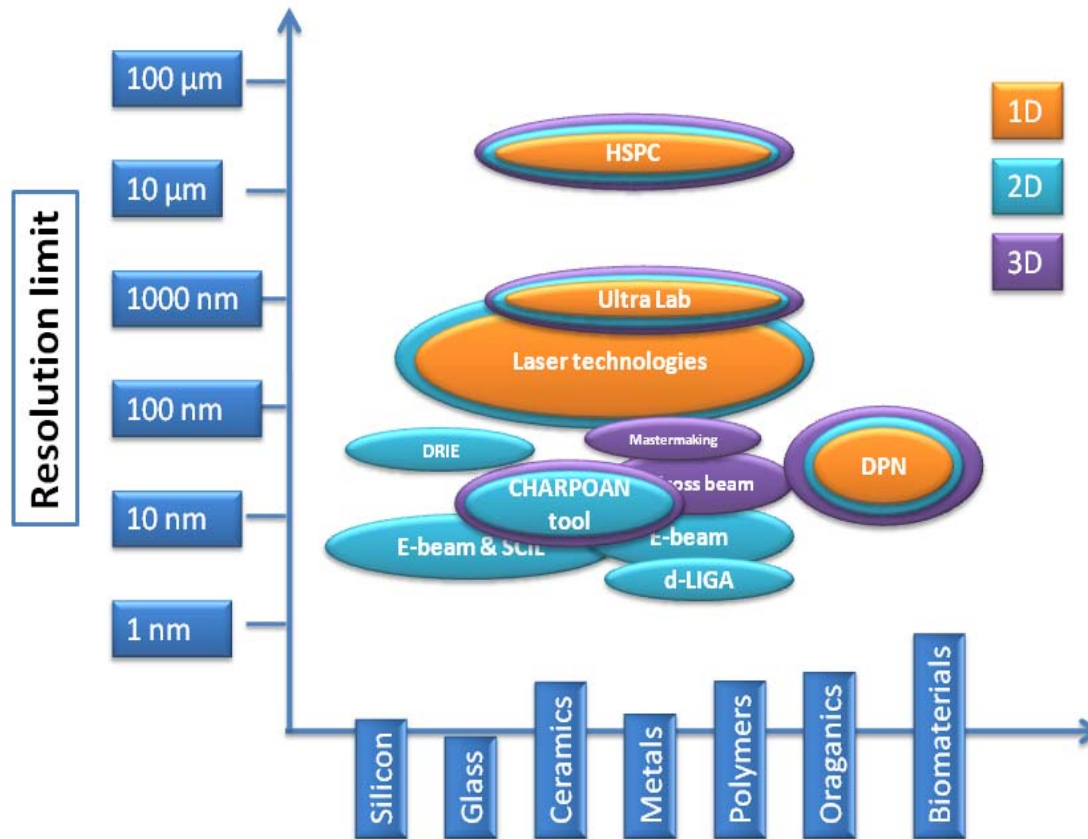
Characterisation

- ✚ HRTEM
- ✚ XPEEM
- ✚ X-ray tomography
- ✚ Auger Nanoprobe
- ✚ In situ synchrotron X-ray diffractometry (> 2010)
- ✚ AFM, conductive AFM
- ✚ Spectrophotometry /-radiometry
- ✚ Profilometry (e.g. low force contact mode & white light mode)
- ✚ μCMM
- ✚ Low force balance, ellipsometry

Comprehensive process portfolio



Master structure making portfolio



Using light, particles and mechanical means for top-down and bottom-up patterning

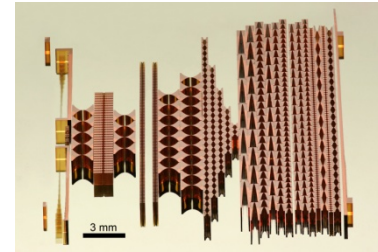
Enabler for various application fields



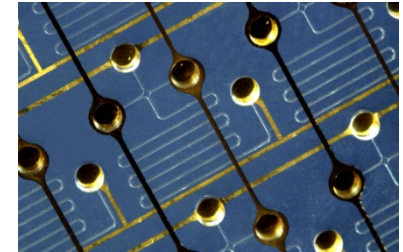
Planetary gear set
@ Tekniker



Micro optical bench @ KIT

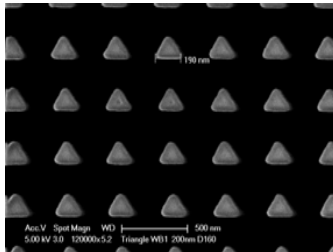


X-ray lenses @ KIT

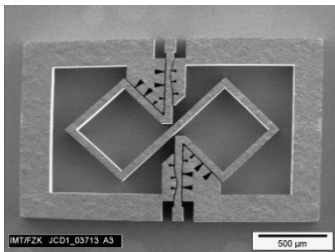


Electrophoresis chip @ KIT

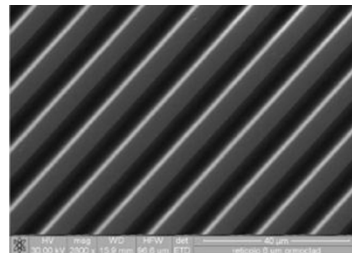
Micro mechanics



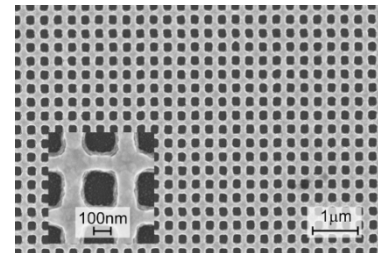
Noble metals thin film ©
MiPlaza



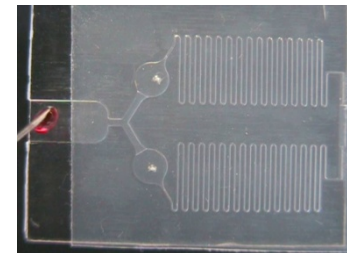
RF structures
@ KIT



Diffractive grating @ CRF



Photonic crystal structures @ KIT



Micro fluidic device
@ Tekniker

Micro fluidics

Micro- and nano optics

Spectroscopy

Energy

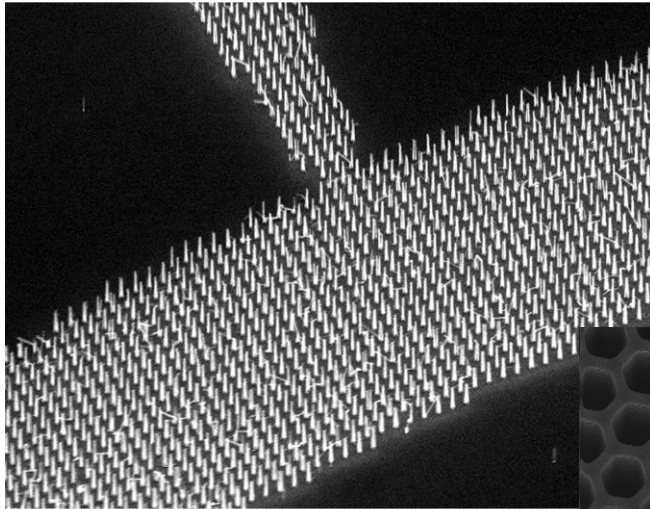
Communication &
Data Storage

Health care

Automotive

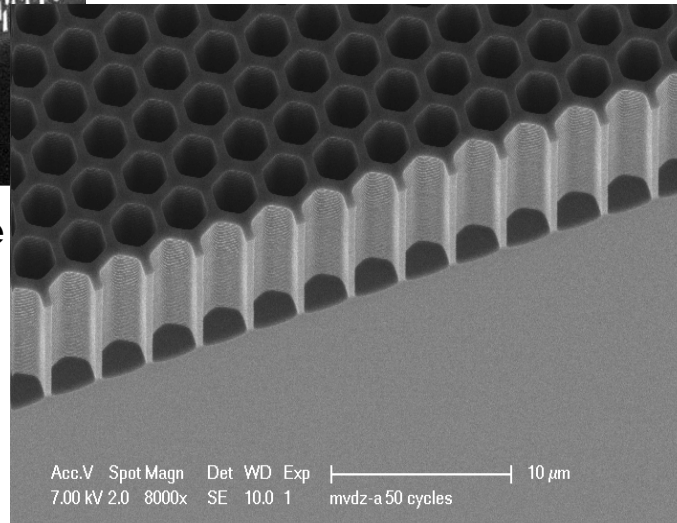
Life Science

Some Examples: Micro & Nano Patterning



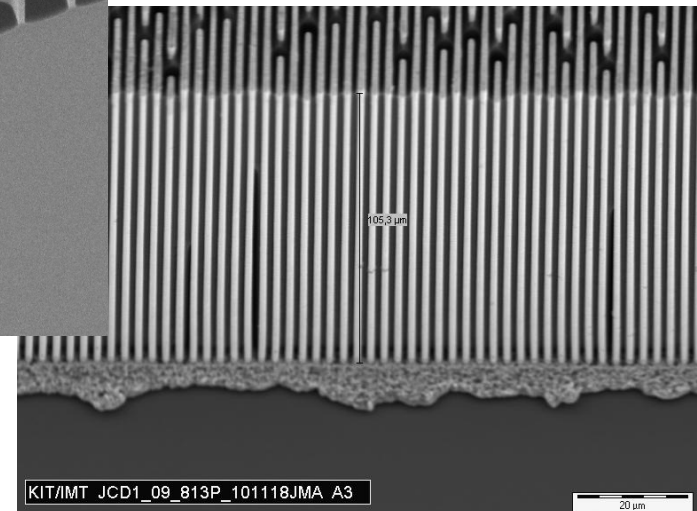
Gold dots for nanowire growth (© MiPlaza)

- ★ Lithography (E-beam, UV, X-ray, Dip Pen)
- ★ Laser patterning
- ★ Reactive ion etching
- ★ Ion Beam patterning



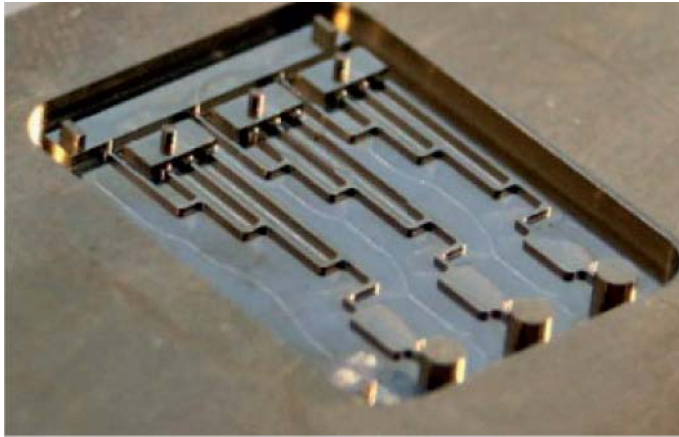
Deep RIE of Si, RIE of metals and SiNx and SiOx (© MiPlaza, KIT)

X-ray lithography for HAR structures (© KIT)

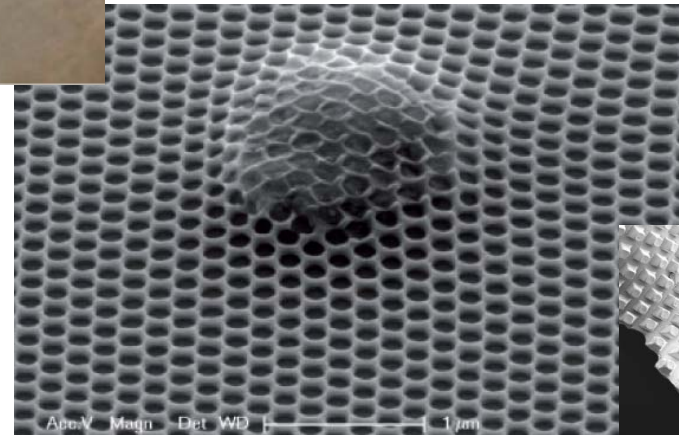


Some Examples: Replication

- Micro & Nano Imprinting
- Micro injection moulding
- Reactive ion etching
- Hot embossing



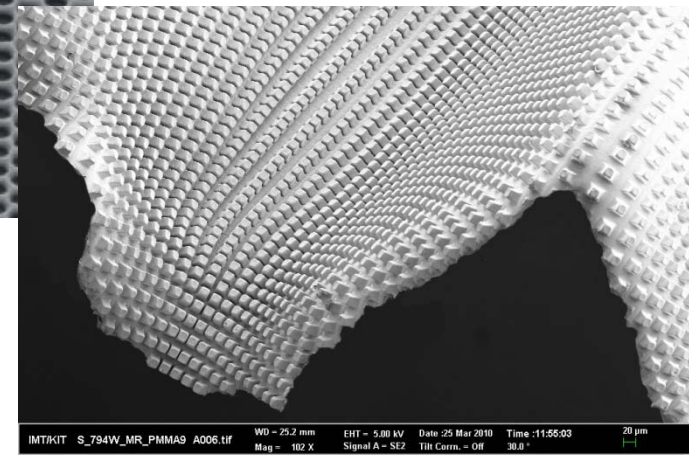
mould inserts for hot embossing
(© Cardiff University, @ KIT)



Blow moulding of micro structures with nano structured surfaces
(© KIT)

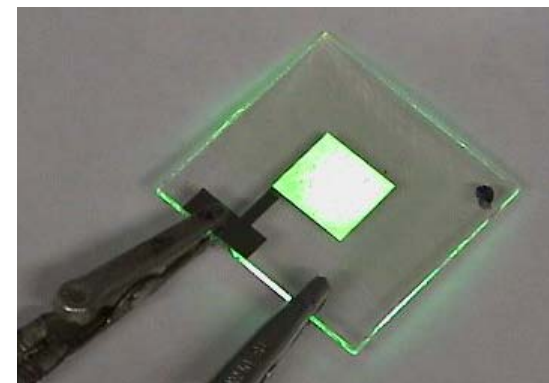


nano printing on curved surfaces
(© Philips MiPlaza)

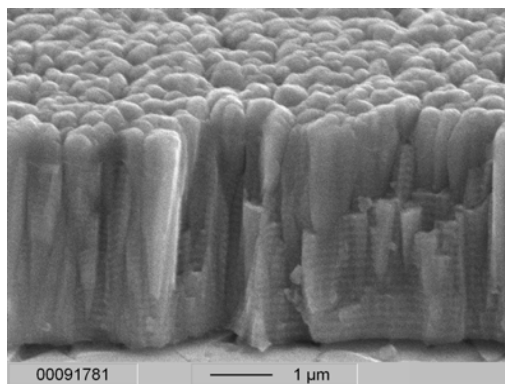


Some Examples: Thin film deposition

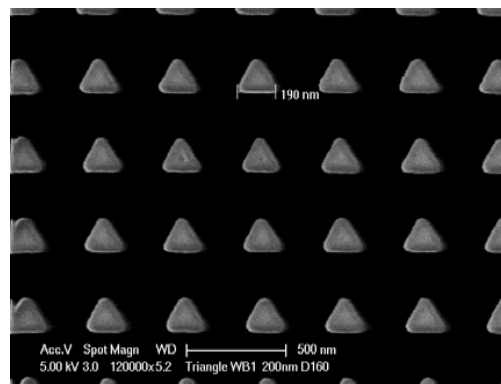
- ★ CVD
- ★ PVD Cluster for layers and coating tools and organic device fabrication
- ★ Self assembling tools
- ★ Thin film noble metals
- ★ Optical Coatings: since September 2010



OLED single pixel (10x10 mm) fabricated by vacuum deposition
© Centro Ricerche FIAT



Fracture surface of a TiN/ZrN multilayer coating © KIT



Noble metals Thin film deposition: 10-1000 nm
© MiPlaza

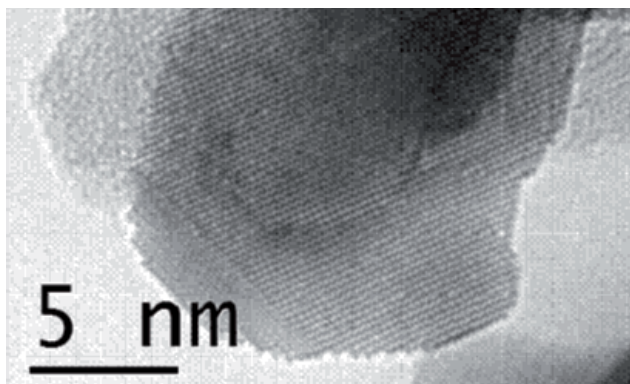
Some Examples: Characterisation

- Transmission Electron Microscopy
- NANO Beam Line (from 2011)
- Electro-optical characterization
- Metrology



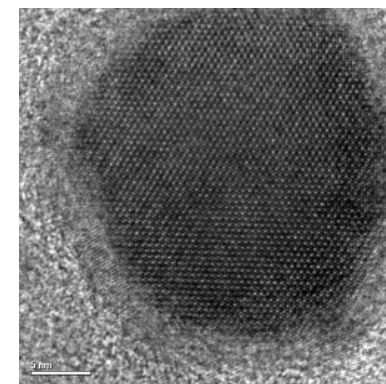
metrological atomic force microscopy

© NPL, KIT



nanomaterials characterisation

© CEA Grenoble



HRTEM image of Co/CoO particles showing the **atomic arrangement** ©KIT

Four steps to get access to EUMINAfab



1.

- ✚ Draft your idea and check EUMINAfab's technology portfolio and services
- ✚ Early contact with scientific experts
- ✚ Create and submit a proposal via on-line submission system (web based virtual entry point)

3.

- ✚ travel to any one of the 8 infrastructures with its specific installations
- ✚ hands-on user operation

2.

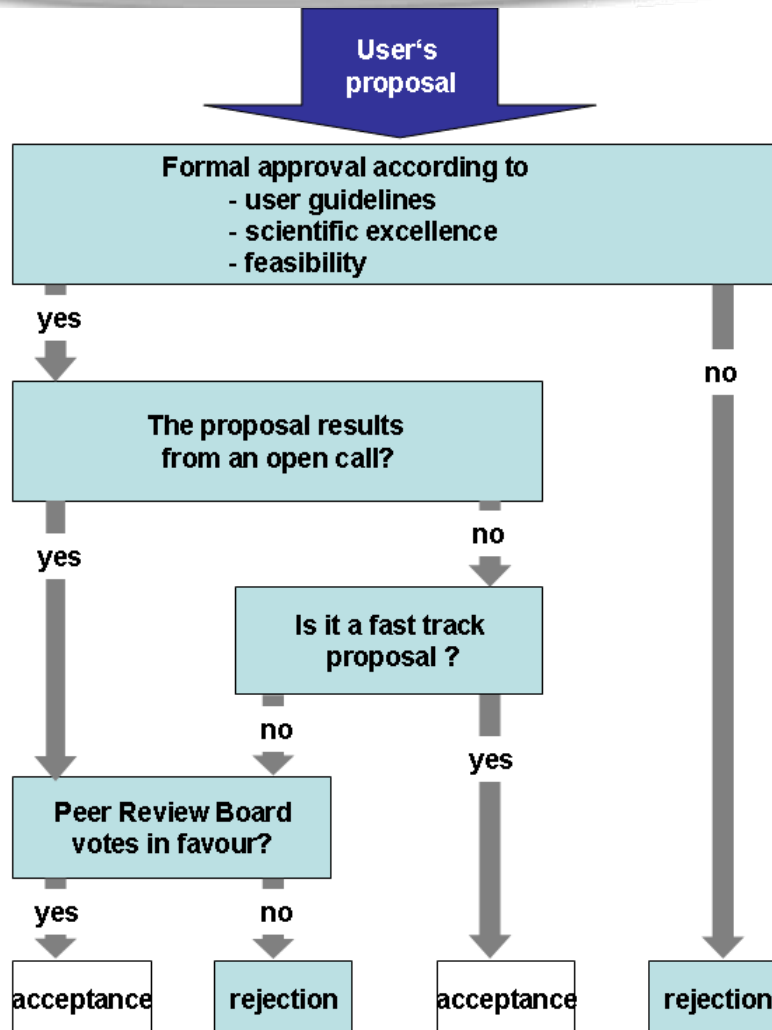
- ✚ Feasibility check by scientific experts and proof of general aspects
- ✚ Independent evaluation by EUMINAfab Peer Review Board

4.

- ✚ Analysis of your experimental data together with scientific expert
- ✚ Publication of results derived at EUMINAfab's installations

continuous submission

<http://www.euminafab.eu>



Review criteria

- Significance and potential of the research
- Degree of novelty
- Necessity of the proposed installations for the work

Priority is given to

- Users from new member states
- New users

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- Technology portfolio
- Select technologies
- Level of experience

User request form

- Project summary
- Work to be performed
- Reasons for selecting each technology
- Critical dimensions

Project Summary
Should include work to be performed, reasons for selecting each technology, critical dimensions to be reached.

Technologies (optional)
Select one or more technologies which you prefer.

Micro and nano patterning technologies:

- CHARPAN - Charged Particle Nanopatterning
- Dip-Pen Nanolithography
- Direct X-Ray Lithography
- E-Beam and SCIL
- Electron Beam Lithography
- FIB/SEM Cross Beam XB1540
- HSPC micromachine (Diamond Milling)
- Laser Material Processing @ Cardiff
- Laser Material Processing @ Karlsruhe
- Mastermaking
- NIL LAB - Modules for Micro and Nanoreplication
- Photopolymer technology
- Surface nanotexturation
- ULTRA LAB - Ultraprecision machining

Thin film deposition technologies:

- FB-MOCVD
- LTPS Line
- Noble Metal
- PVD Magnetron
- PVD Cluster for metals, ceramic and glass
- PVD-Cluster for organic device fabrication
- DLI - MOCVD
- Self Assembly tools

Replication technologies:

- Etching: DRIE and RIE
- Polymer and nanoimprinting
- Micro-Injection Moulding
- Micro and Nano Imprinting
- REPLICATION LAB - Microreplication
- Screen printing machine

Characterisation technologies:

- Auger nanoprobe
- Electro-optical characterization
- HRTEM TITAN
- METRO LAB - Micrometrology
- Metrology at NPL
- TEM
- XPEEM

- ✪ Gain access to technologies & application-oriented expertise
- ✪ We can adapt our state-of-the-art MNT to your individual requirements
- ✪ Accelerate development cycles of our users by providing open access to validated, interoperable MNT
- ✪ Technology Experts are available from the beginning of an idea through to the end of the user project.
- ✪ You can experiment with new ideas
- ✪ Don't need to take own equipment out of service to make trial runs
- ✪ Don't need to invest in expensive equipment for a one off task
- ✪ No fee access, travel costs refunded

- ✪ Future products will be based increasingly on multimaterials' processing
- ✪ EUMINAfab is a *European Research Infrastructure* with open access to processing technologies for a multitude of functional materials
- ✪ Open for users from academia and industry
- ✪ Access is free of cost, if results are intended for publication
- ✪ Proprietary research by individual arrangement with access providing partner: not reported to E.C. or other partners
- ✪ Access is granted upon scientific merit by an independent peer review process
- ✪ Submit your proposal, discuss your idea with our experts or get in touch with EUMINAfab via www.euminafab.eu

- ✪ EUMINAFAB gives access to all kind of micro and nano technology needs (not only to micro optics & photonics)
- ✪ EUMINAFAB offers additional technologies which are not available in ACTMOST and vice versa
- ✪ EUMINAFAB addresses mainly the academic world
- ✪ The technology must not exist in your country
- ✪ External peer review board
- ✪ Criteria only scientific merit

- ✪ *EUMINAfab partners, scientists and experts at KIT, CU-MEC, CEA-liten, CRF, KTH, TEKNIKER, PHILIPS, FhG, NPL*
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