HZDR Summer Student Programm

FINDING THE OPTIMUM CONDITIONS FOR FMR – MEASUREMENTS ON GLASS SPHERES CAPPED WITH CO/PT MULTILAYER

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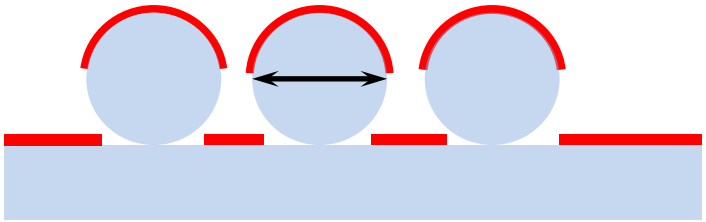
Outline

- Motivation & Glass spheres system
- Experimental setup
  - Scanning Electron Microscopy (SEM)
- Results
  - SEM – images
  - Before Liftoff
  - After Liftoff
- Conclusion

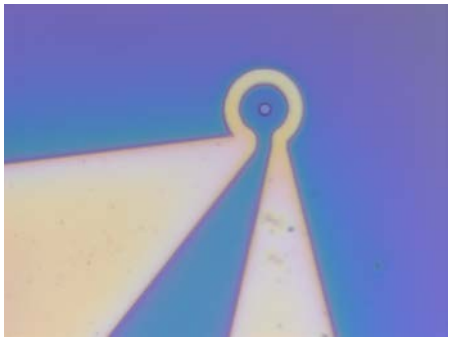
Motivation

- System : glass spheres with ferromagnetic layer on surface

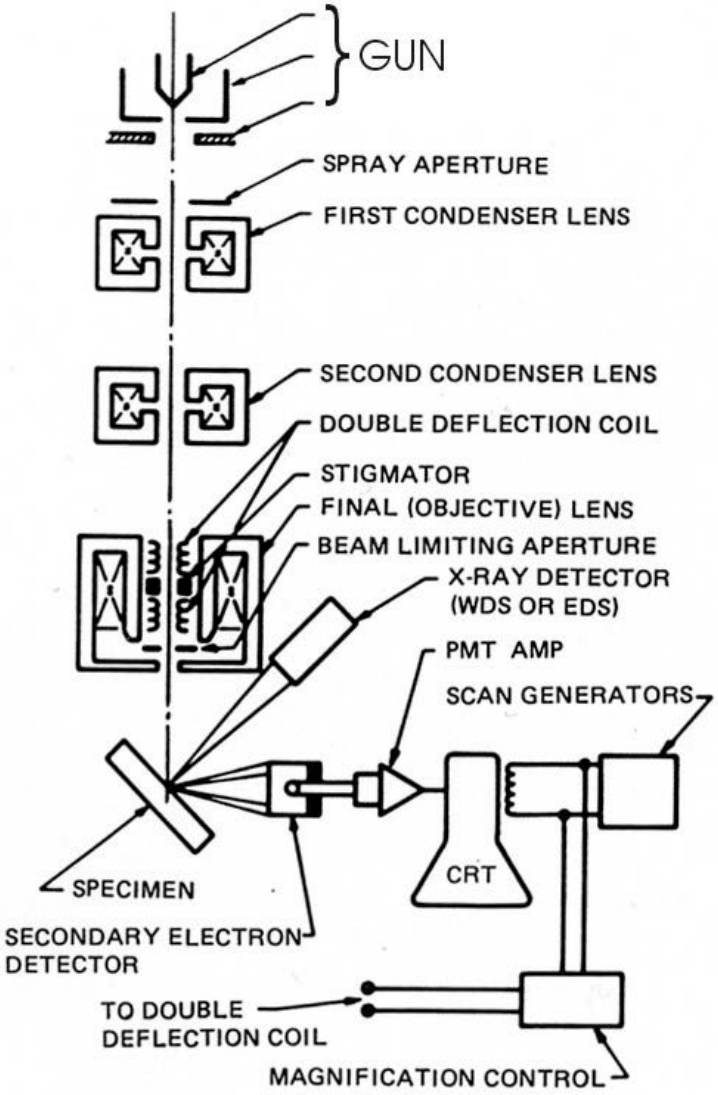


- What do we want to measure?
  - ✓ FMR of one glass sphere

- What do we need to make this experiment?
  - ✓Microresonator with optimum hole diameter

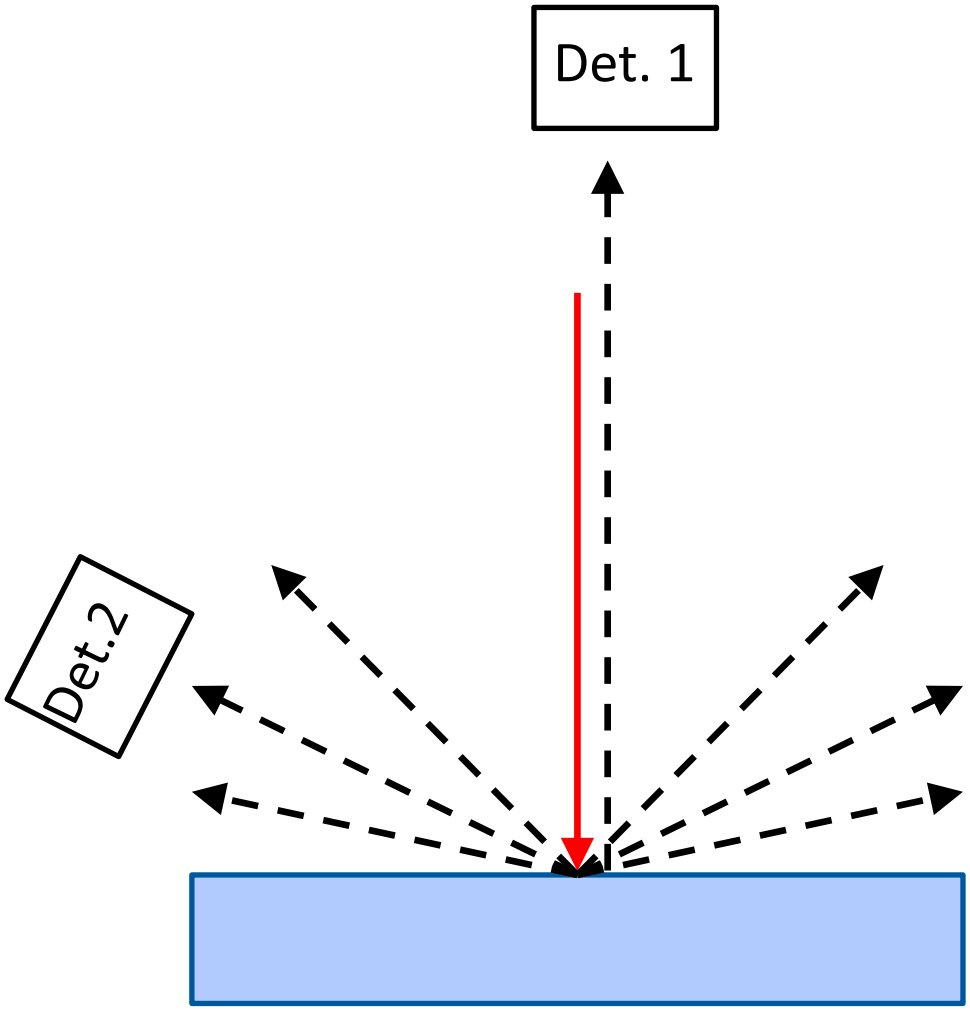


Scanning Electron Microscopy (SEM)



Susan Swapp, University of Wyoming

SEM - picture



Incident electron-beam

Reflected electron-beam

Det. 1 - detector of back-scattered electrons
Det. 2 – detector of secondary electrons

Scanning Electron Microscopy (SEM)

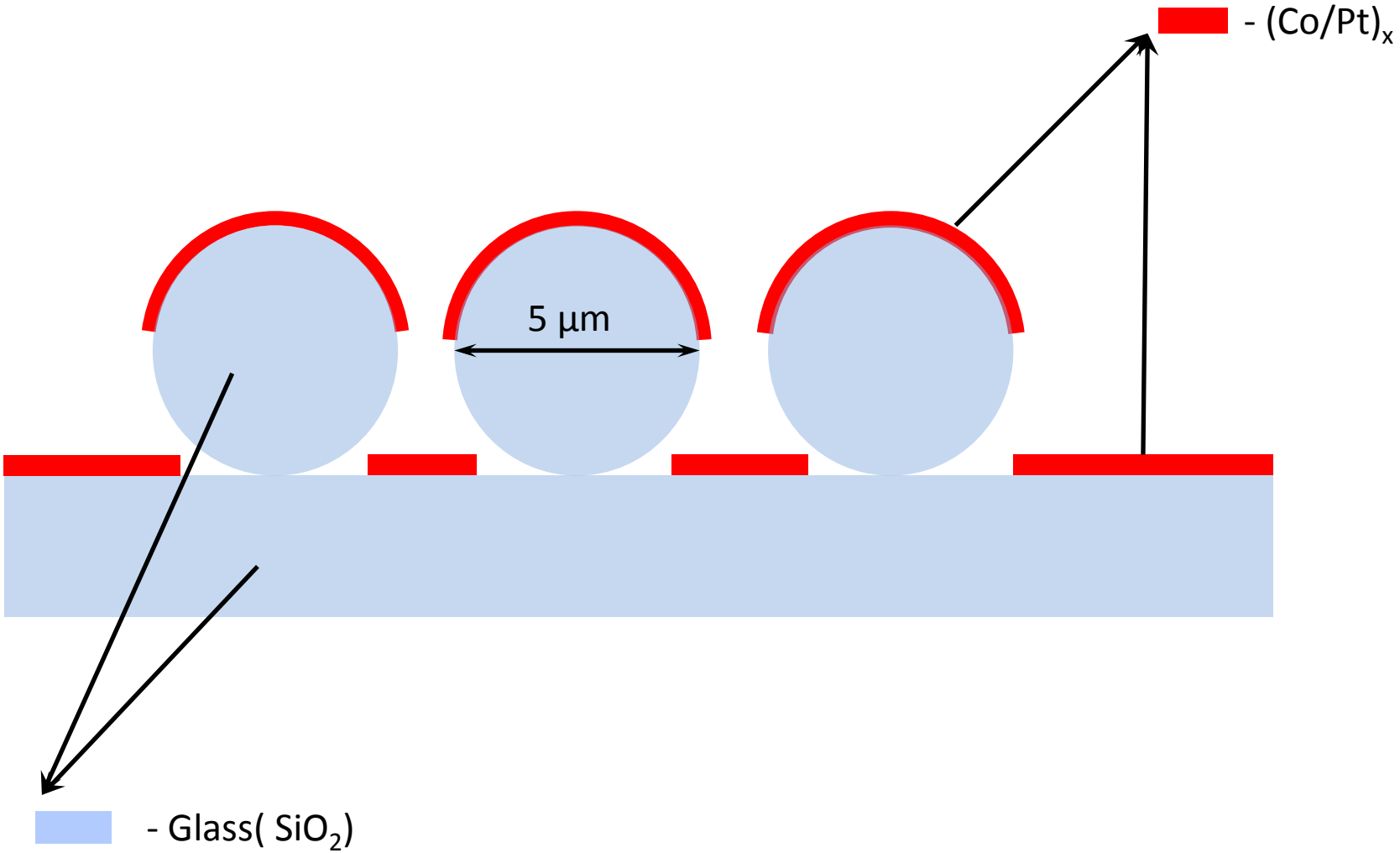
Advantages

- Critical in all fields that require characterization of solid materials.
- Comparatively easy to operate.
- Data acquisition is rapid (less than 5 minutes/image).

Disadvantages

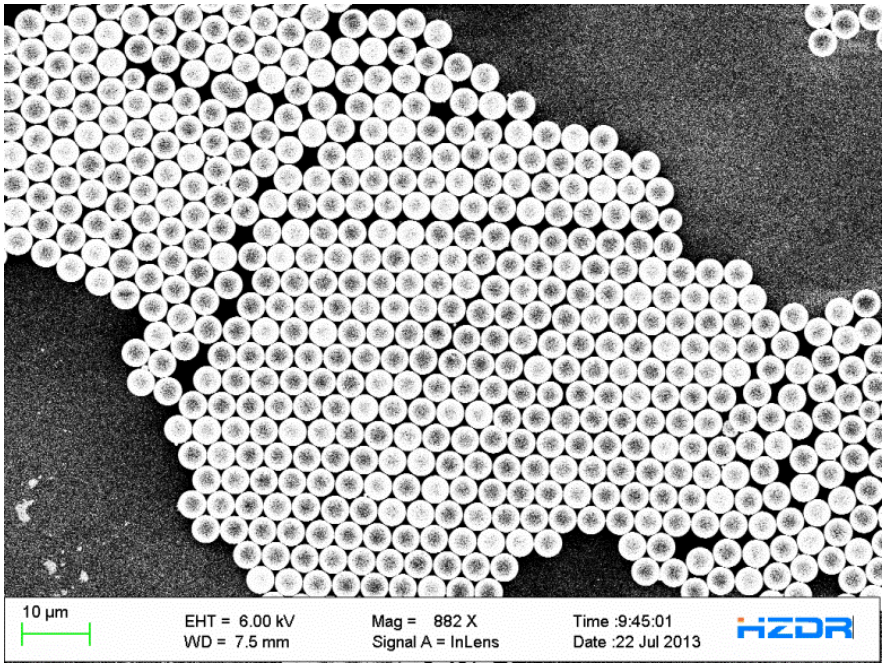
- Samples must be solid and they must fit into the microscope chamber.
- Samples must be stable in a vacuum.
- Cannot detect very light elements (H, He, and Li)

Glass Microspheres System

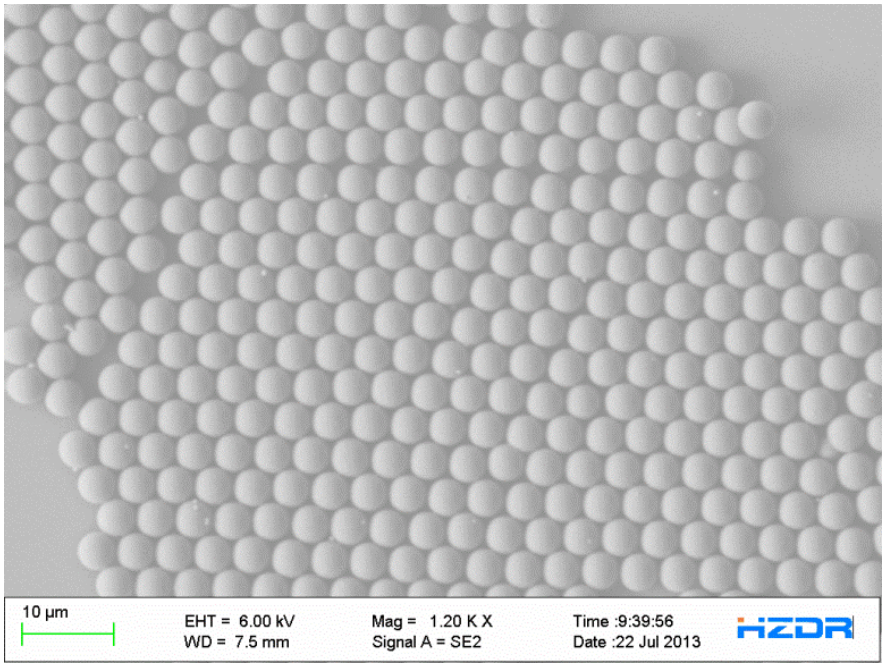


SEM -images

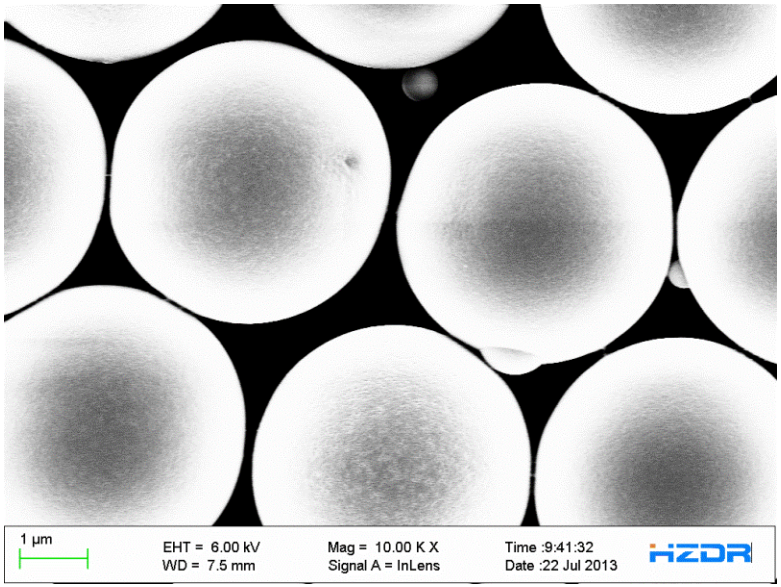
Detector 1

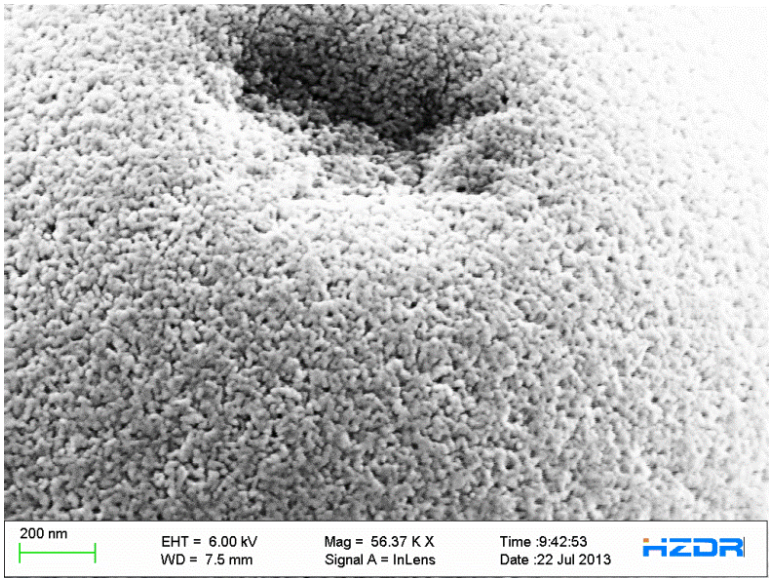


Detector 2



SEM -images


1 µm
EHT = 6.00 kV
WD = 7.5 mm
Mag = 10.00 K X
Signal A = InLens
Time :9:41:32
Date :22 Jul 2013
HZDR


200 nm
EHT = 6.00 kV
WD = 7.5 mm
Mag = 56.37 K X
Signal A = InLens
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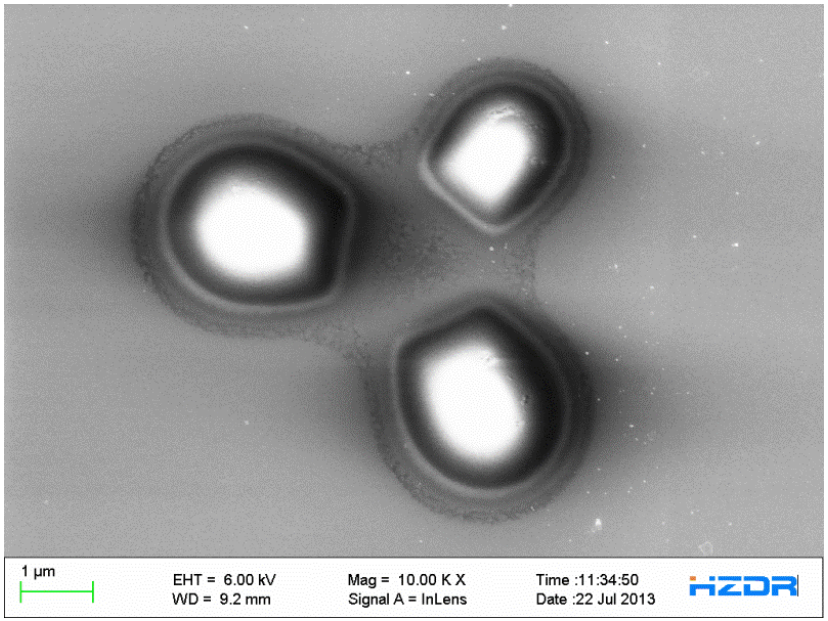
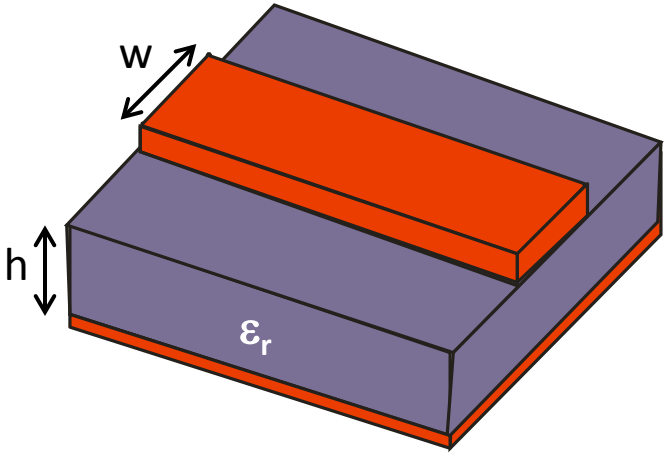
Date :22 Jul 2013
HZDR

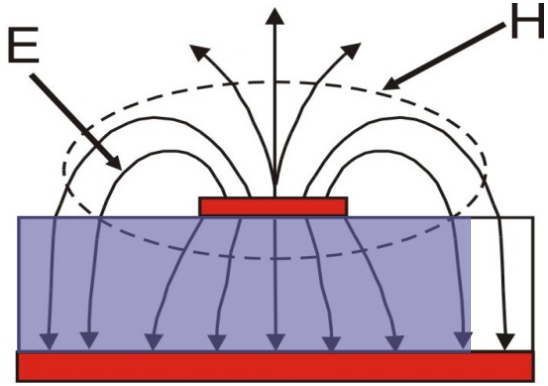

1 µm
EHT = 6.00 kV
WD = 9.2 mm
Mag = 10.00 K X
Signal A = InLens
Time :11:34:50
Date :22 Jul 2013
HZDR

Microstrip waveguide



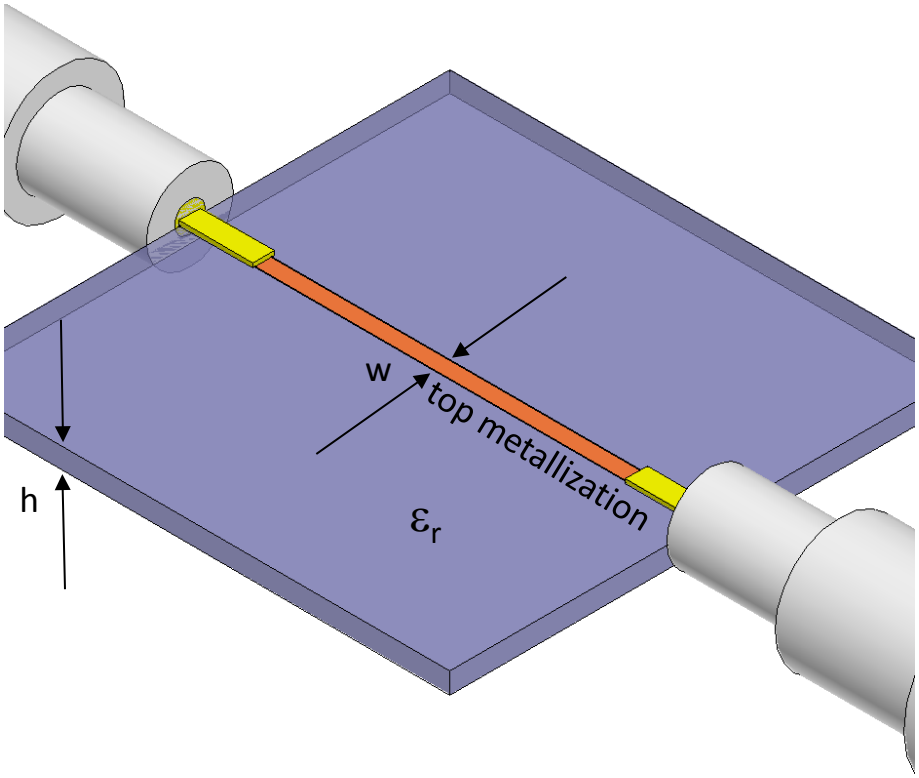
Dielectric

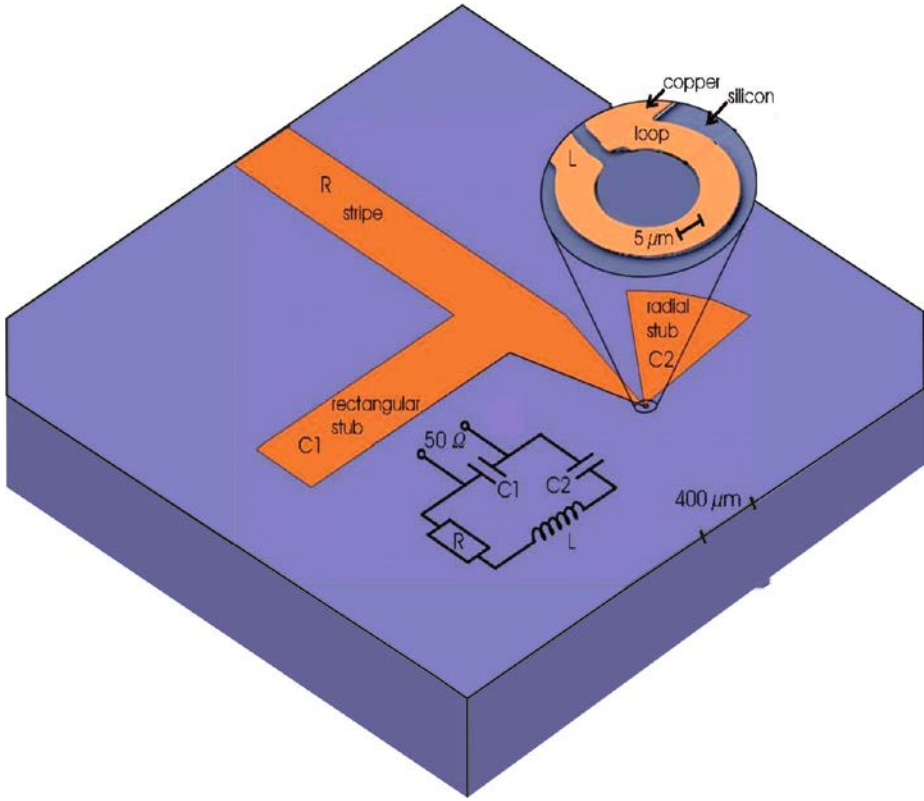
Metal



Microstrip:
Width w, height h, dielectric constant ε determine Impedance, typically 50Ω

Si-Microstrip waveguide ↔ Microresonator

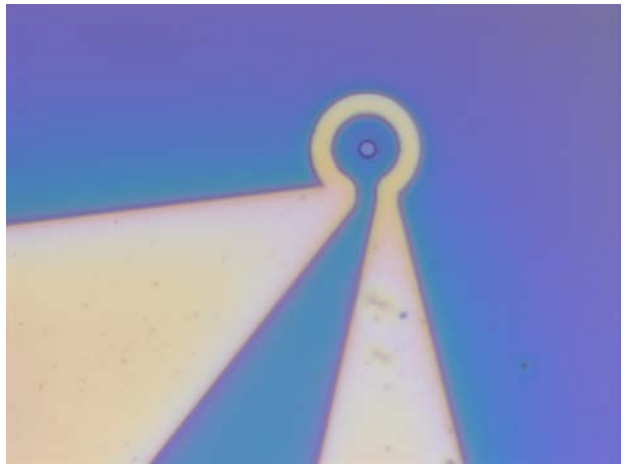


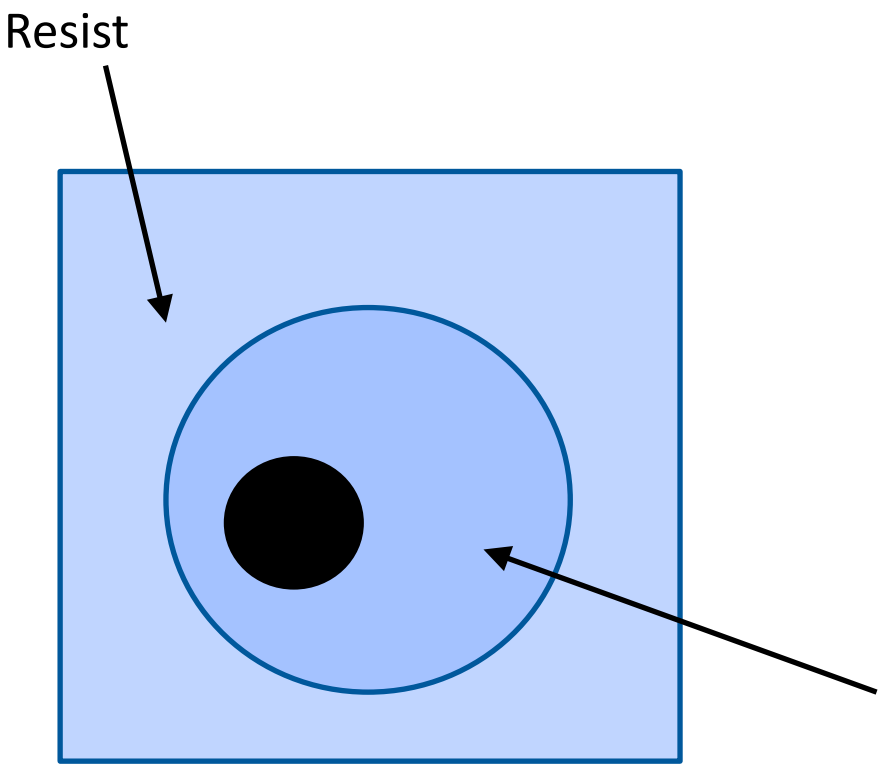


Microstrip waveguide:
Width w, height h,
dielectric constant ε_r

Microresonator:
LCR(oscillator)-circuit

FMR of one sphere

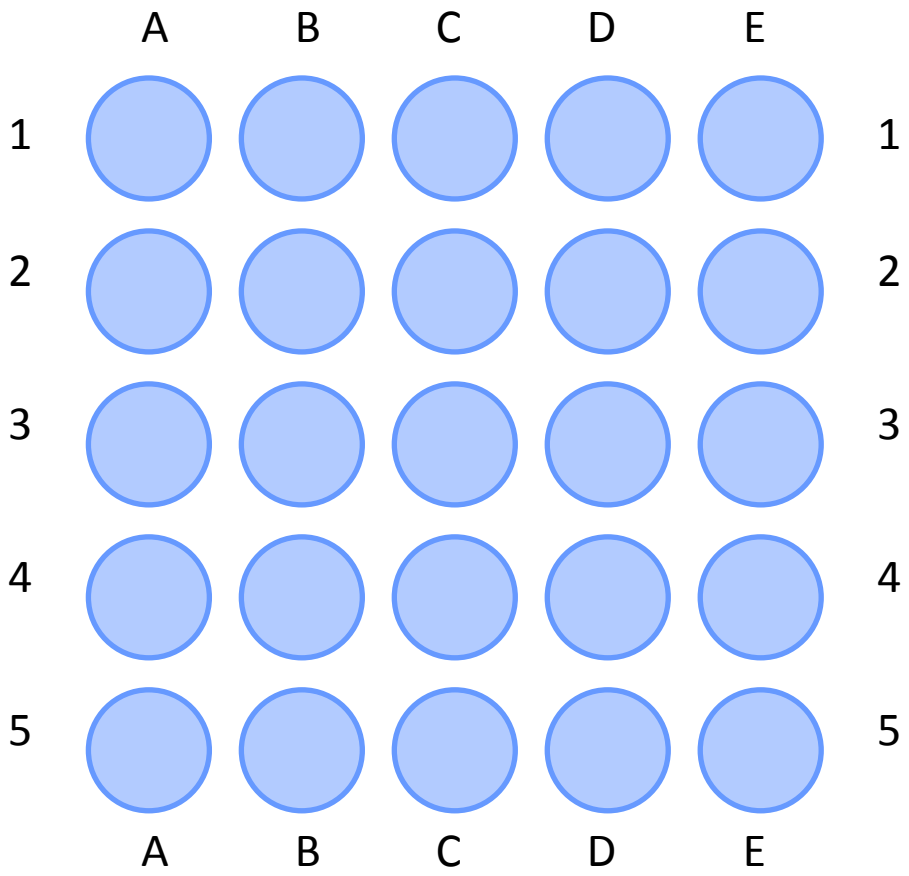




- Only one sphere in the hole!

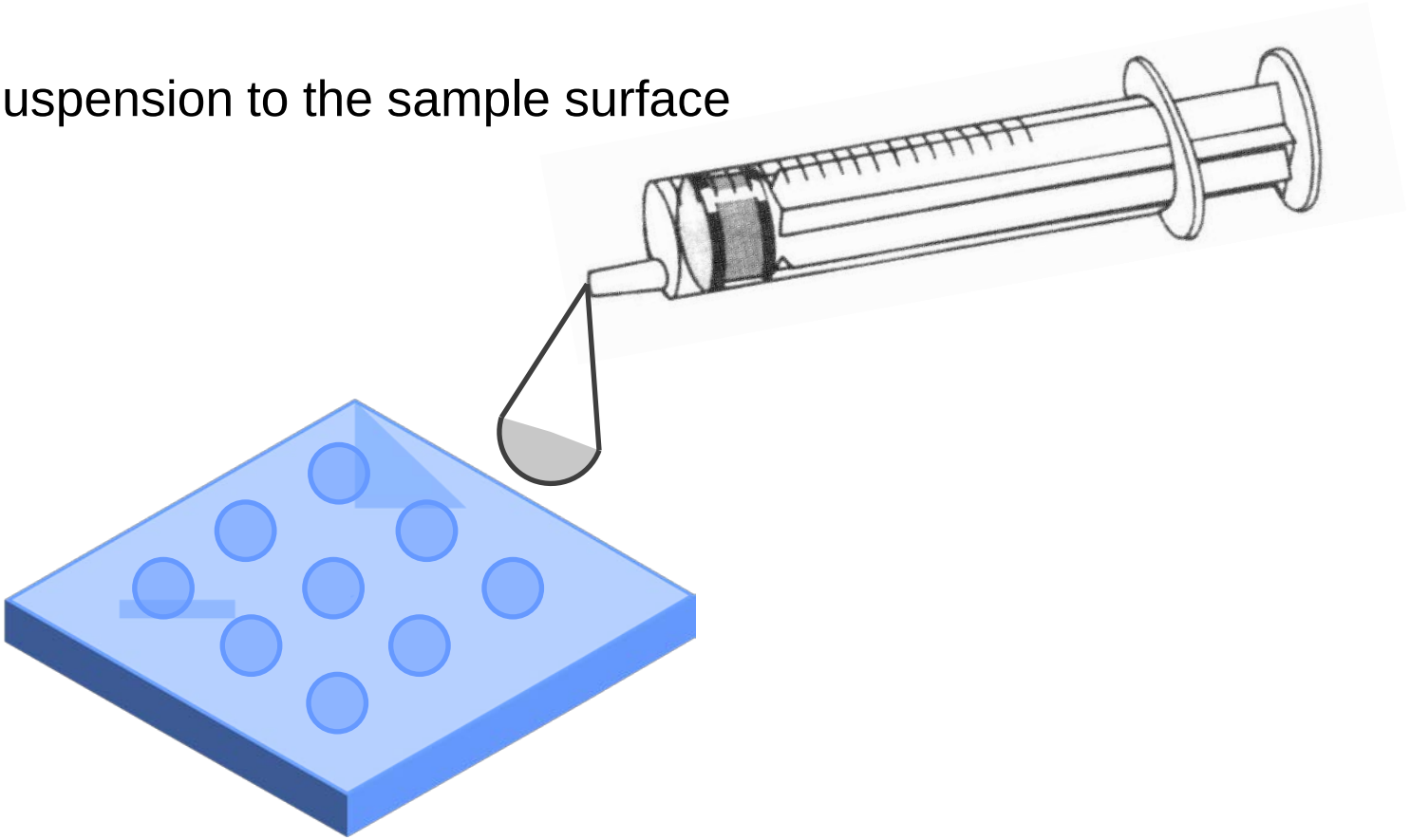
Sample preparation

- Preparation sample structures by using Electron Beam Lithography (EBL)

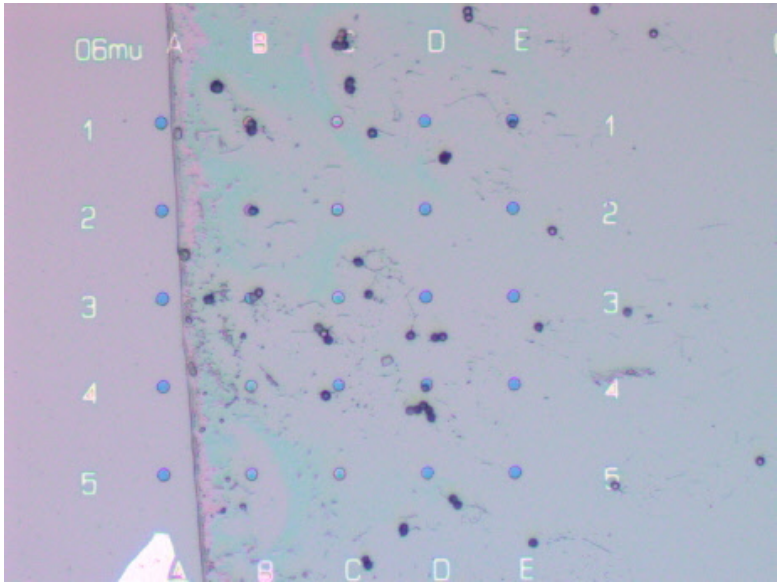


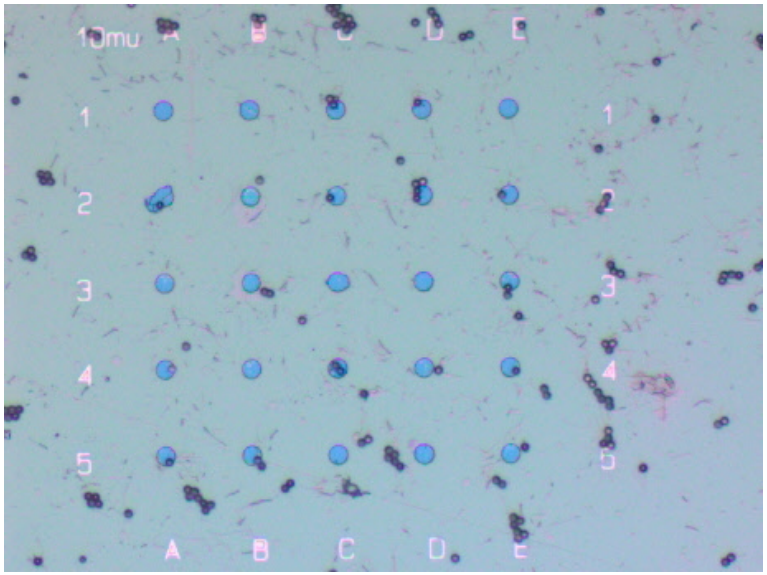
Sample preparation

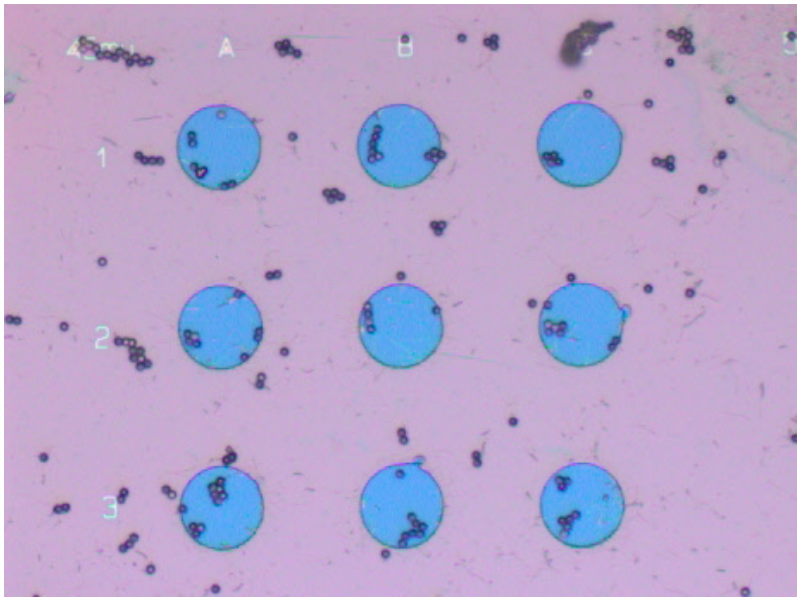
- Ultrasonic destruction of glass substrate.
- Preparation of the suspension = spheres + liquid (ex. water).
- Drop suspension to the sample surface



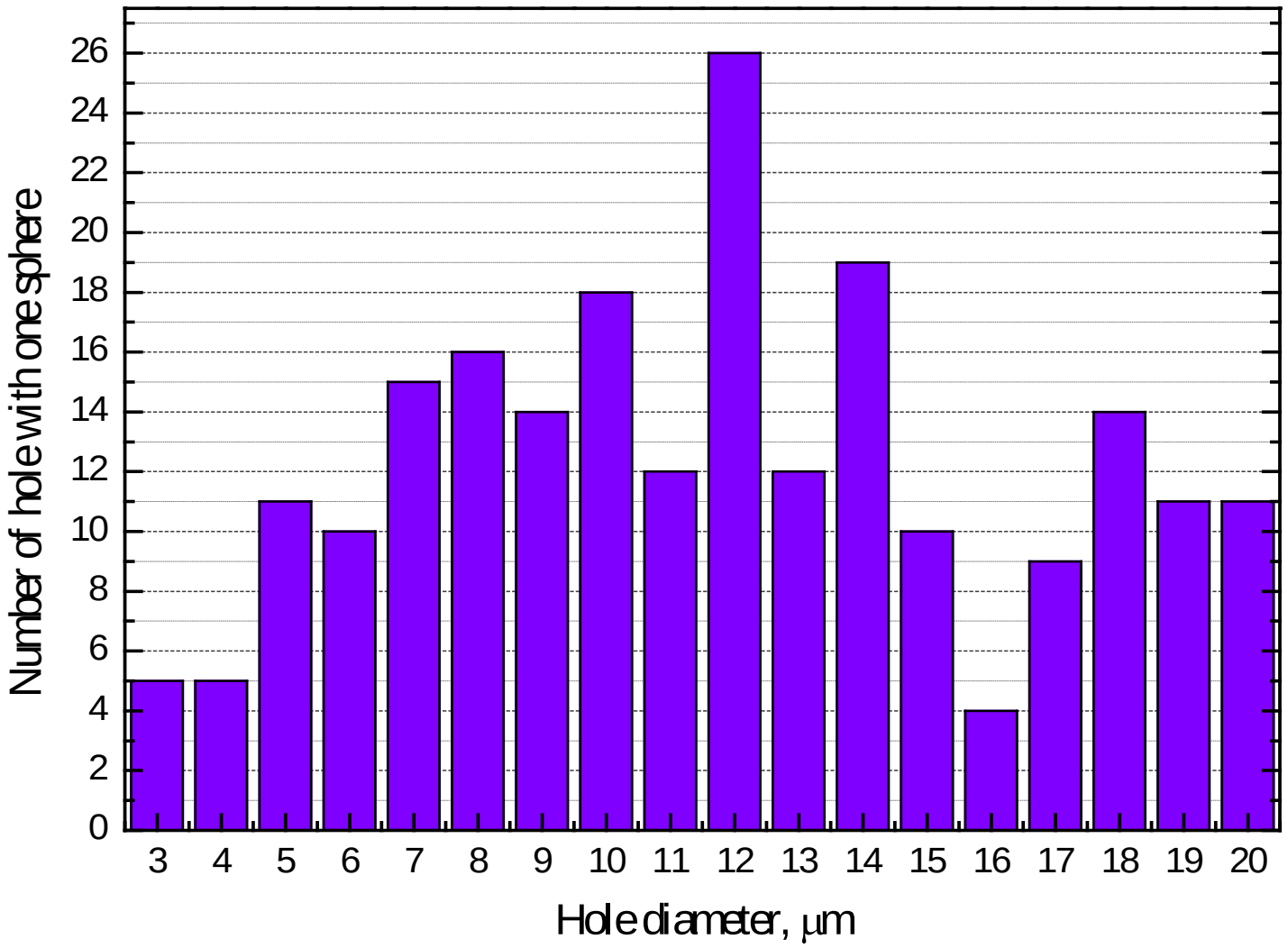
Before Liftoff



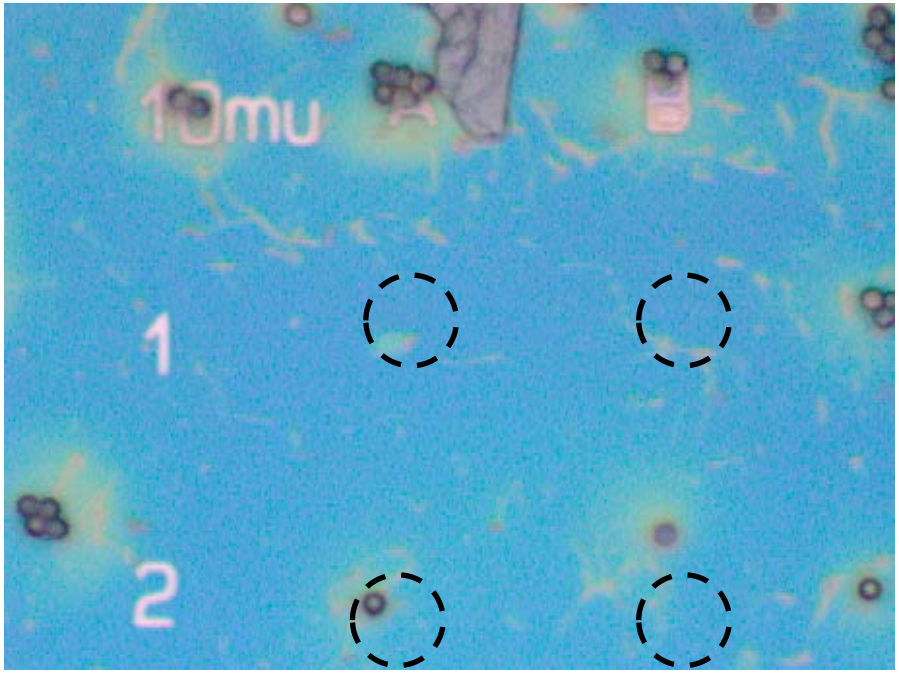


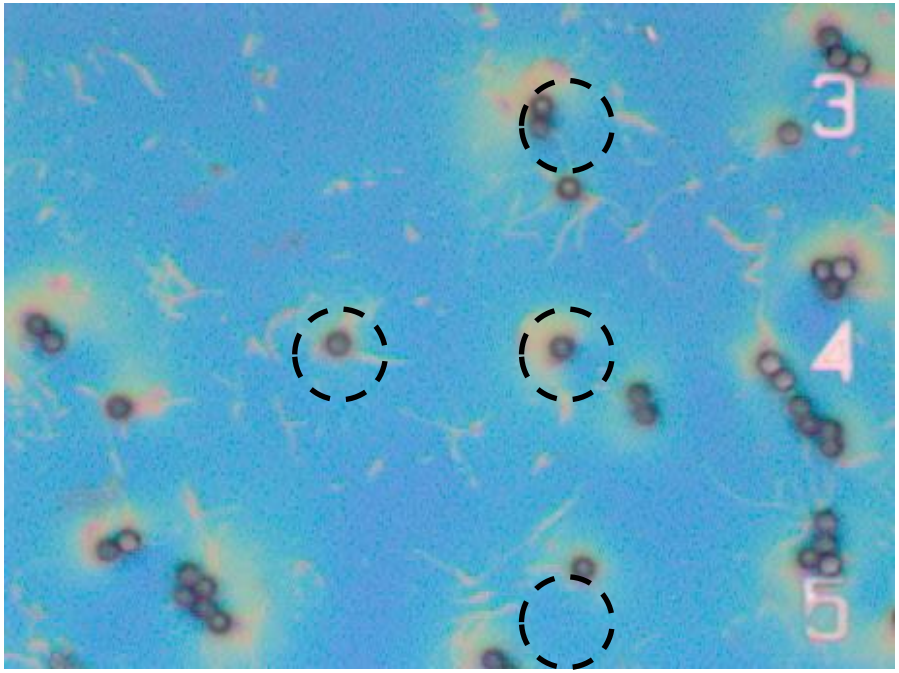


Before Liftoff



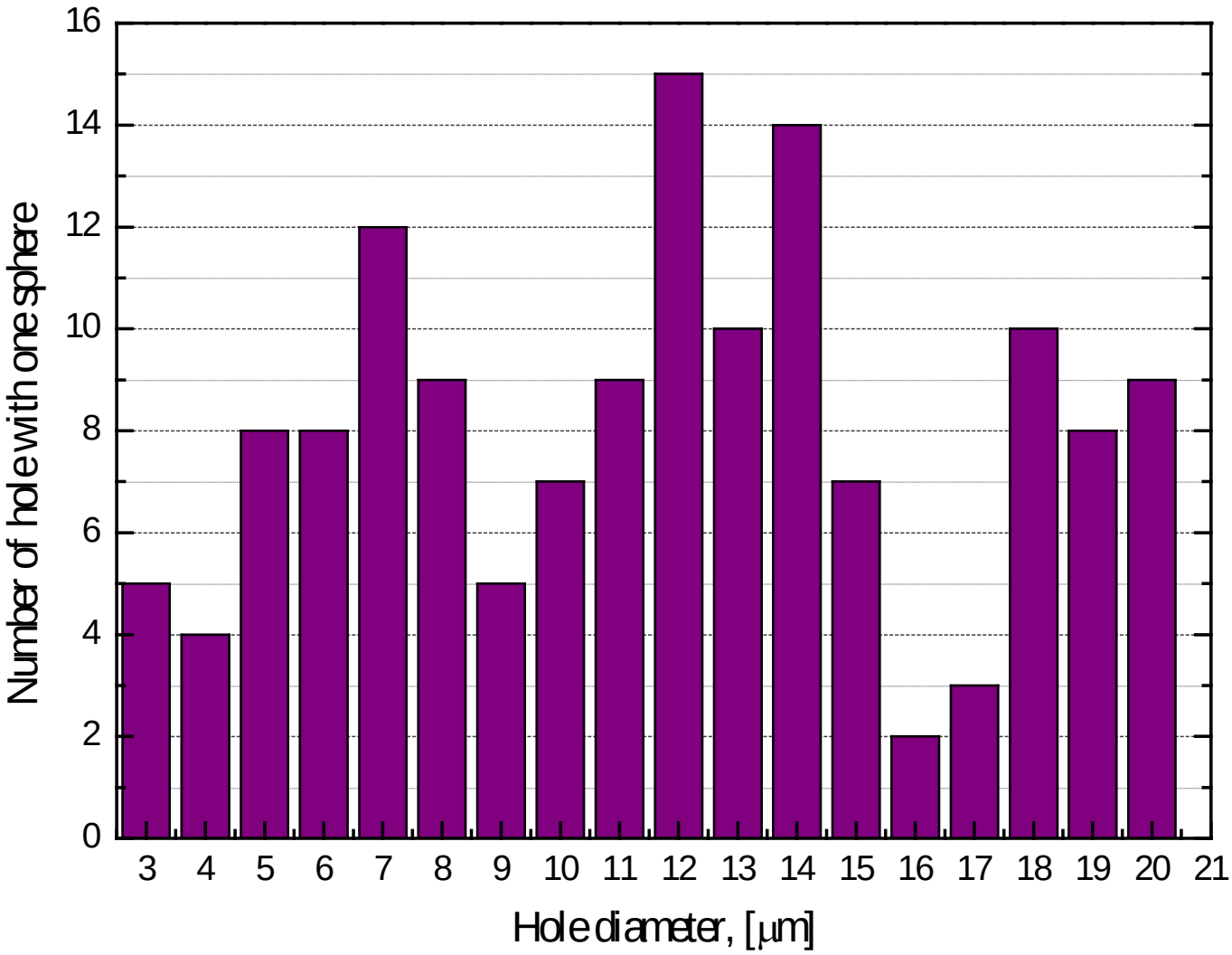
After Liftoff. ø = 10 mu



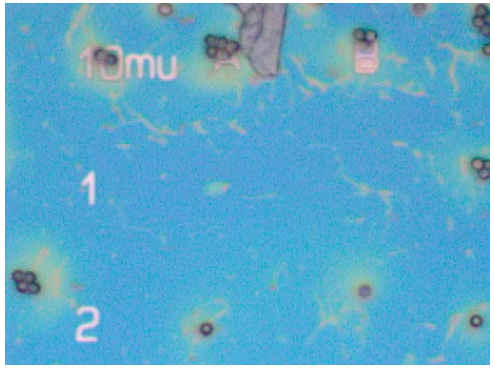


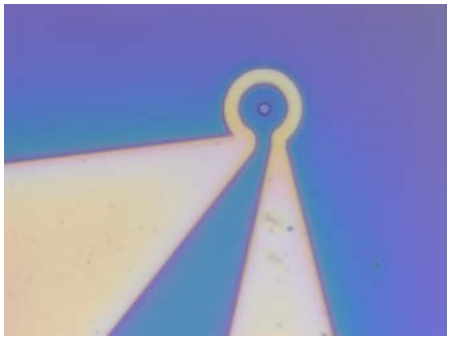
50 µm

After liftoff

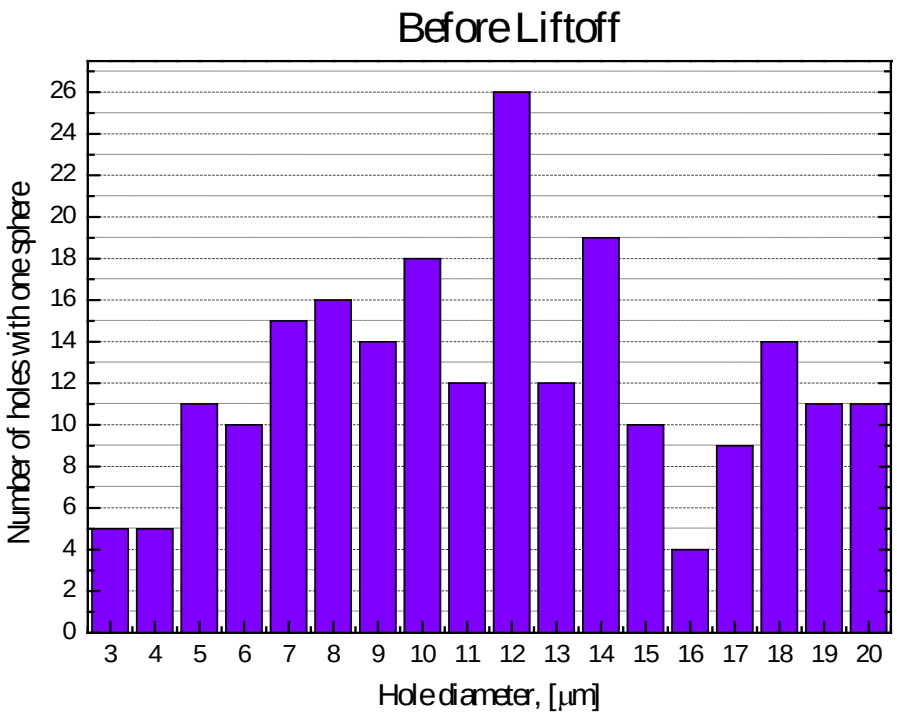


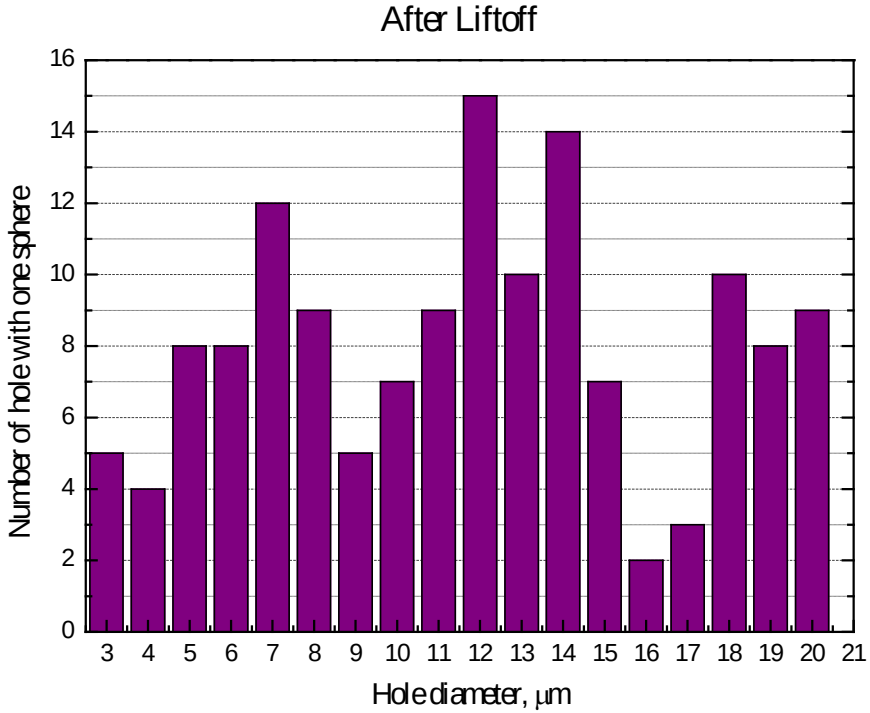
Results





- The optimum hole diameter for microresonator is from 7 µm to14 µm





Acknowledgement

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Thank for your attention!