



Optical trapping with a photonic crystal cavity: A new manipulation technique for microorganisms in water

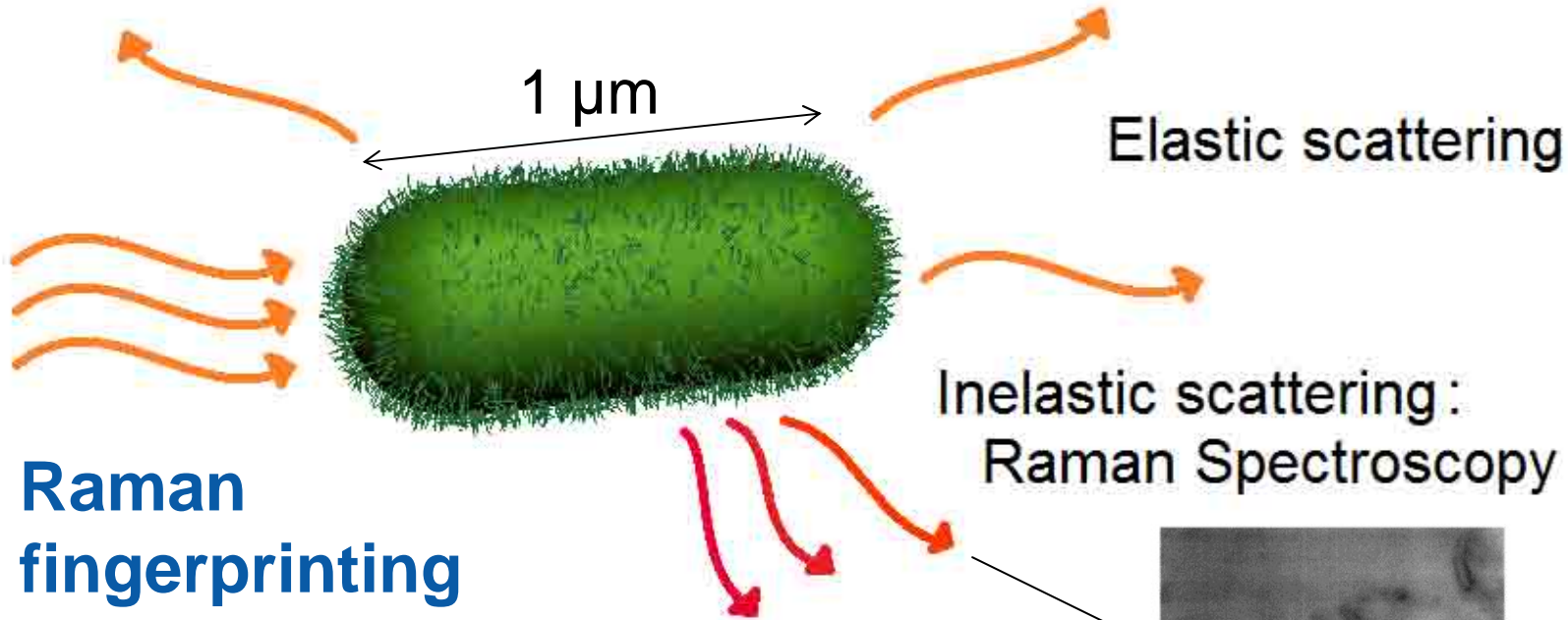
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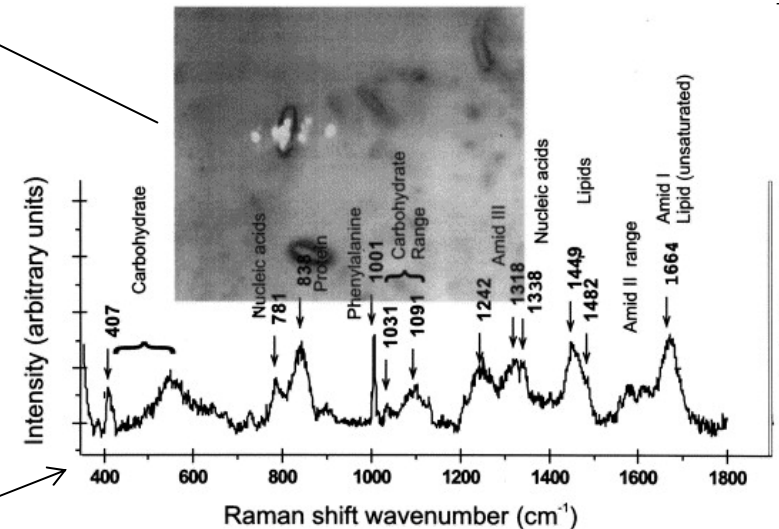
 **TU Delft**

combining scientific excellence with commercial relevance

Research setting



- Raman fingerprinting
- Immobilization: optical trapping
- Online label-free sensing



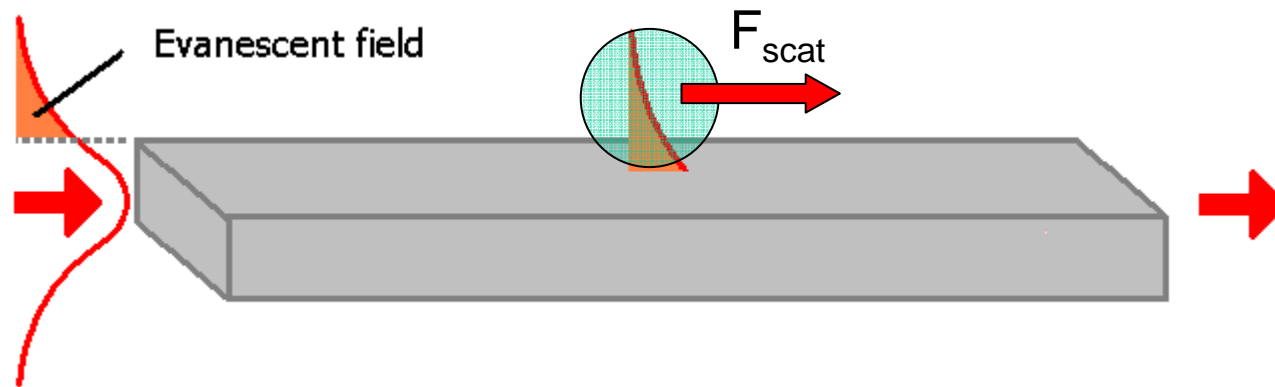
Clostridium acetobutylicum
Schluster et. al., J. Microbiol. Methods (2000)

- **Biophotonics: the powerful combination of**
 - Nanophotonics: Control the flow of light
 - Microfluidics: Control the flow of water
 - Microbiology: Single cell studies
- **Fluidics and photonics rely on well known and compatible fabrication techniques**
- **Promising and rising field, providing Lab-on-chip applications**
 - Water quality monitoring
 - Health care

- 1. Introduction**
- 2. Photonic crystals and cavities**
- 3. Design and fabrication**
- 4. Measurements**
- 5. Conclusion**

1. Introduction

Optical waveguide: fiber on a chip

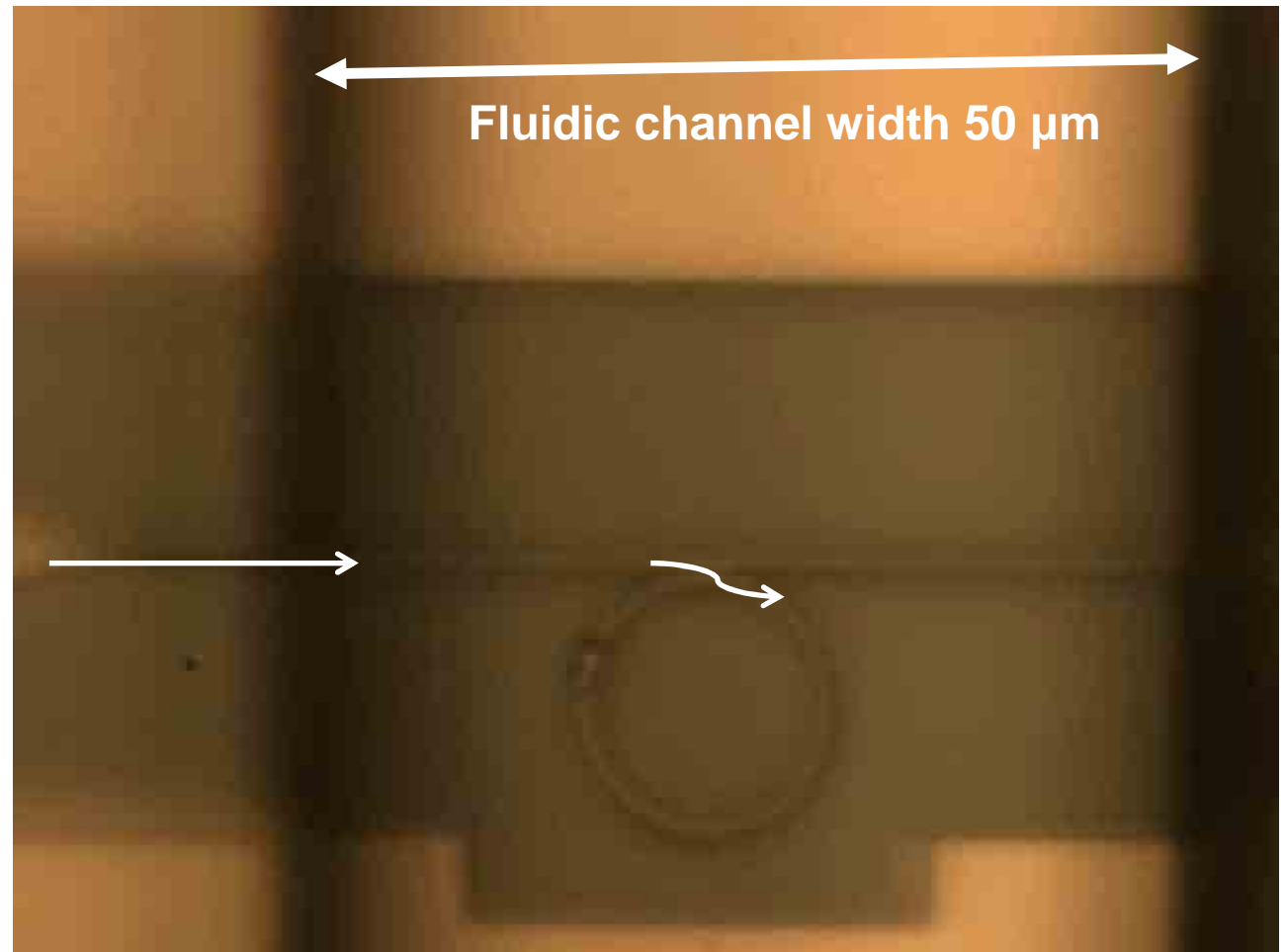


Based in water: Evanescent field can trap small ($\sim \mu\text{m}$) particles and propel them

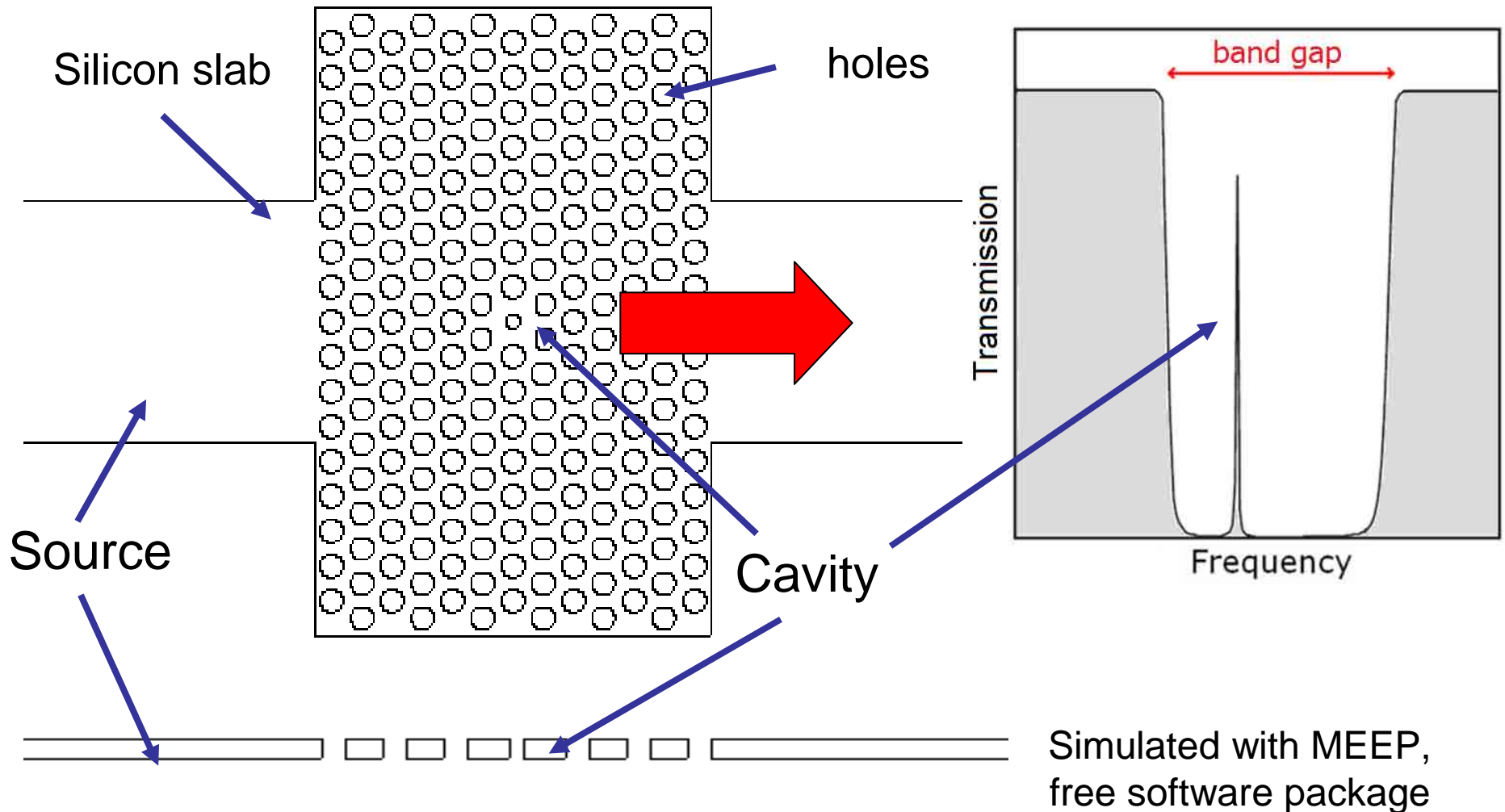
- **Small trapping forces**
- **Raman excitation, but weak**

1. Introduction

- 500X220 nm Silicon bus waveguide
- Ring resonator enhances field
- 1 μm polystyrene beads
- $v=9 \mu\text{m/s}$

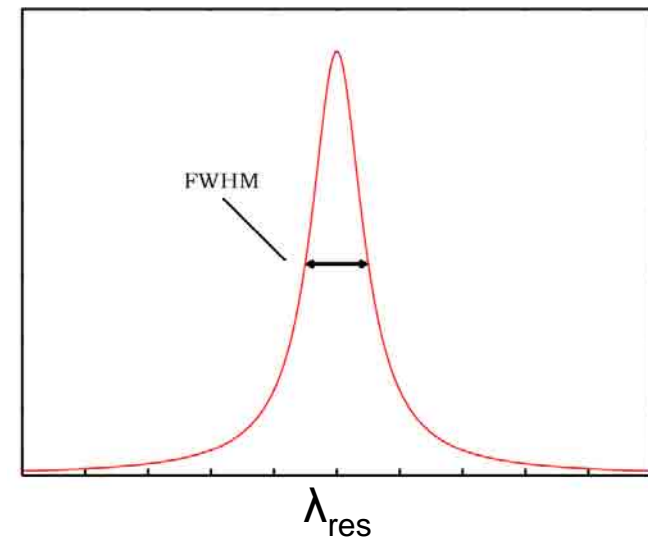
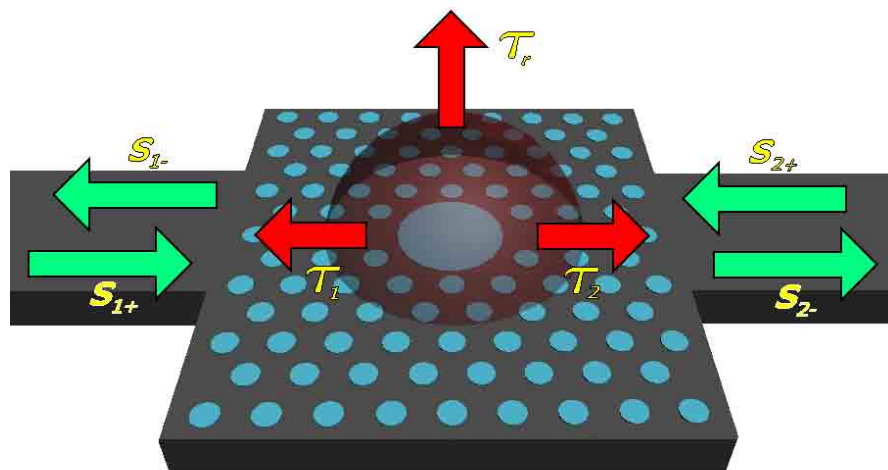


2. Photonic crystal cavity



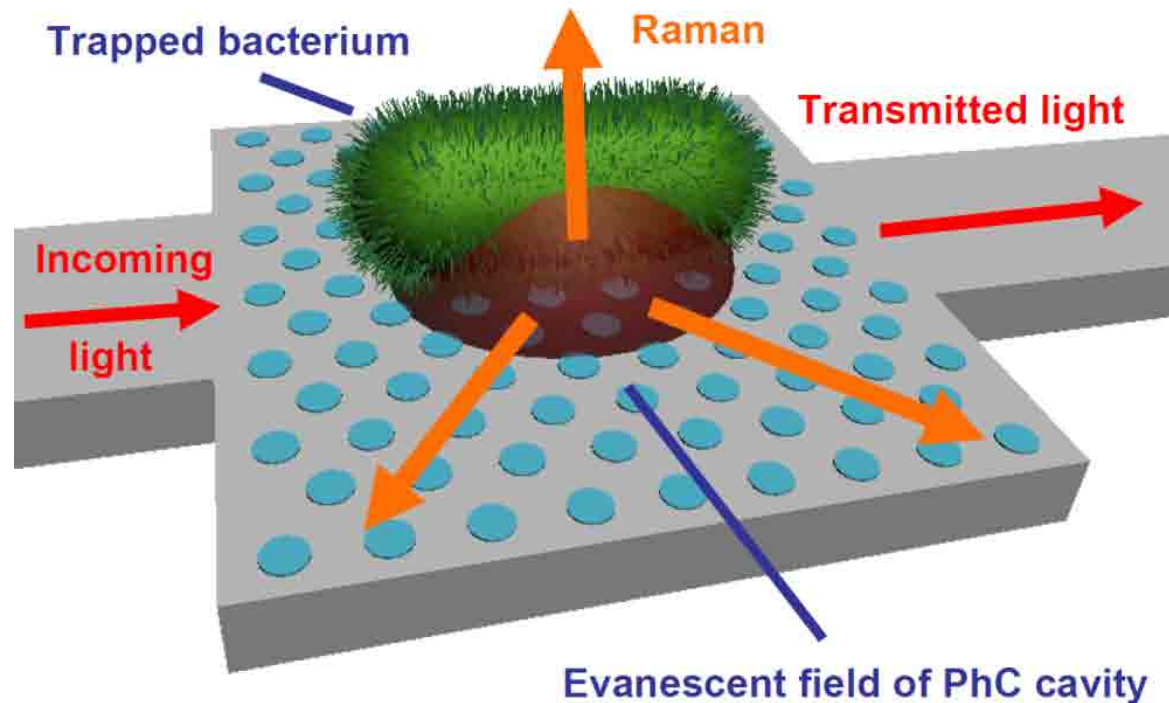
2. Photonic crystal cavity

- **Quality of a cavity resonance:**
 - Resonance lifetime τ
 - Energy in the cavity
 - Width of the resonance peak



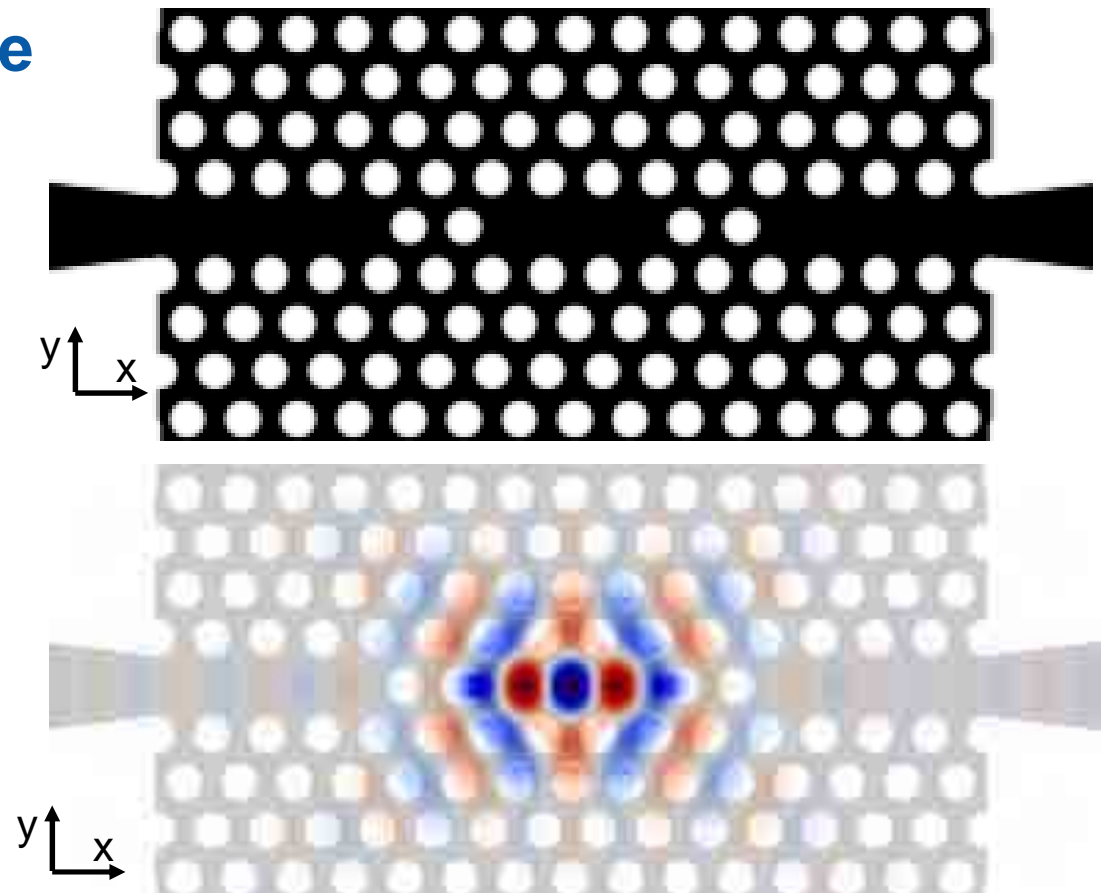
2. Photonic crystal cavity

- **Resonance E-field enhancement:**
 - Optical trapping & Raman Excitation



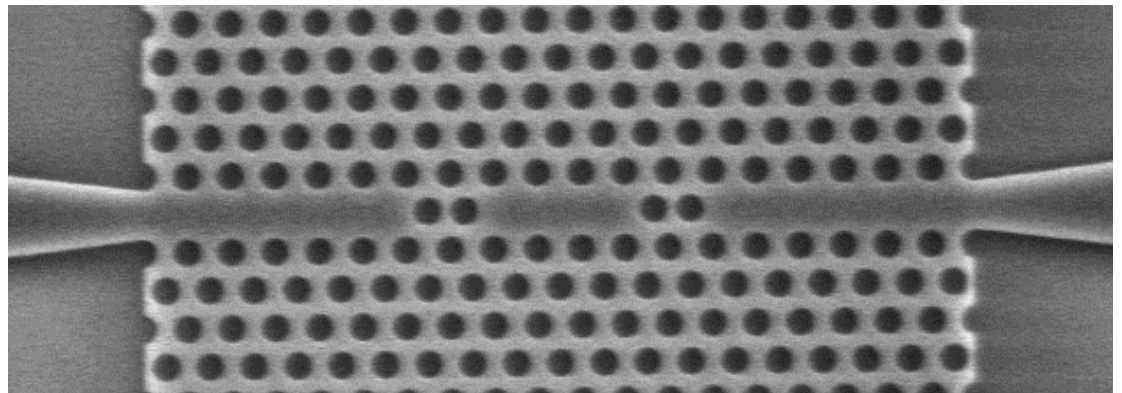
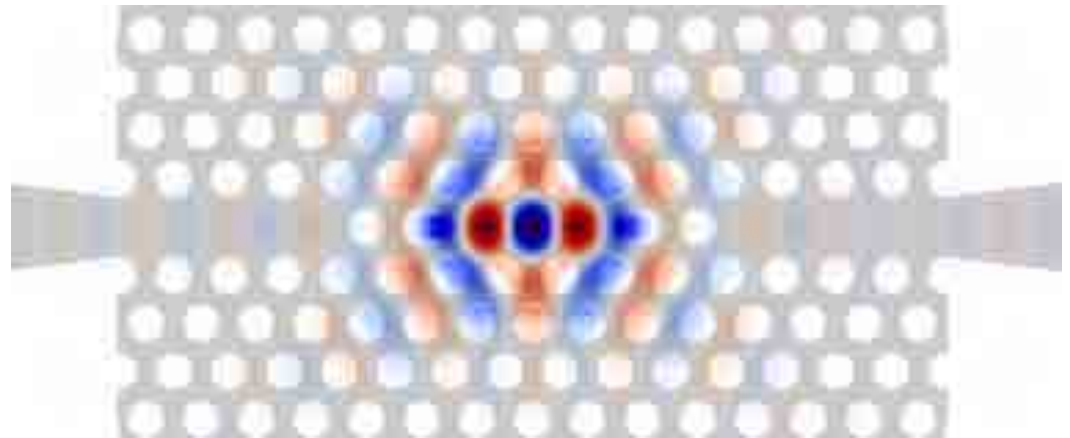
3. Design and fabrication

- Design and simulate with MEEP
- Cavity choice
L3: 3 holes out
- Simulation shows E_y of the resonance
- Q factor: ~ 1000 in aquatic environment



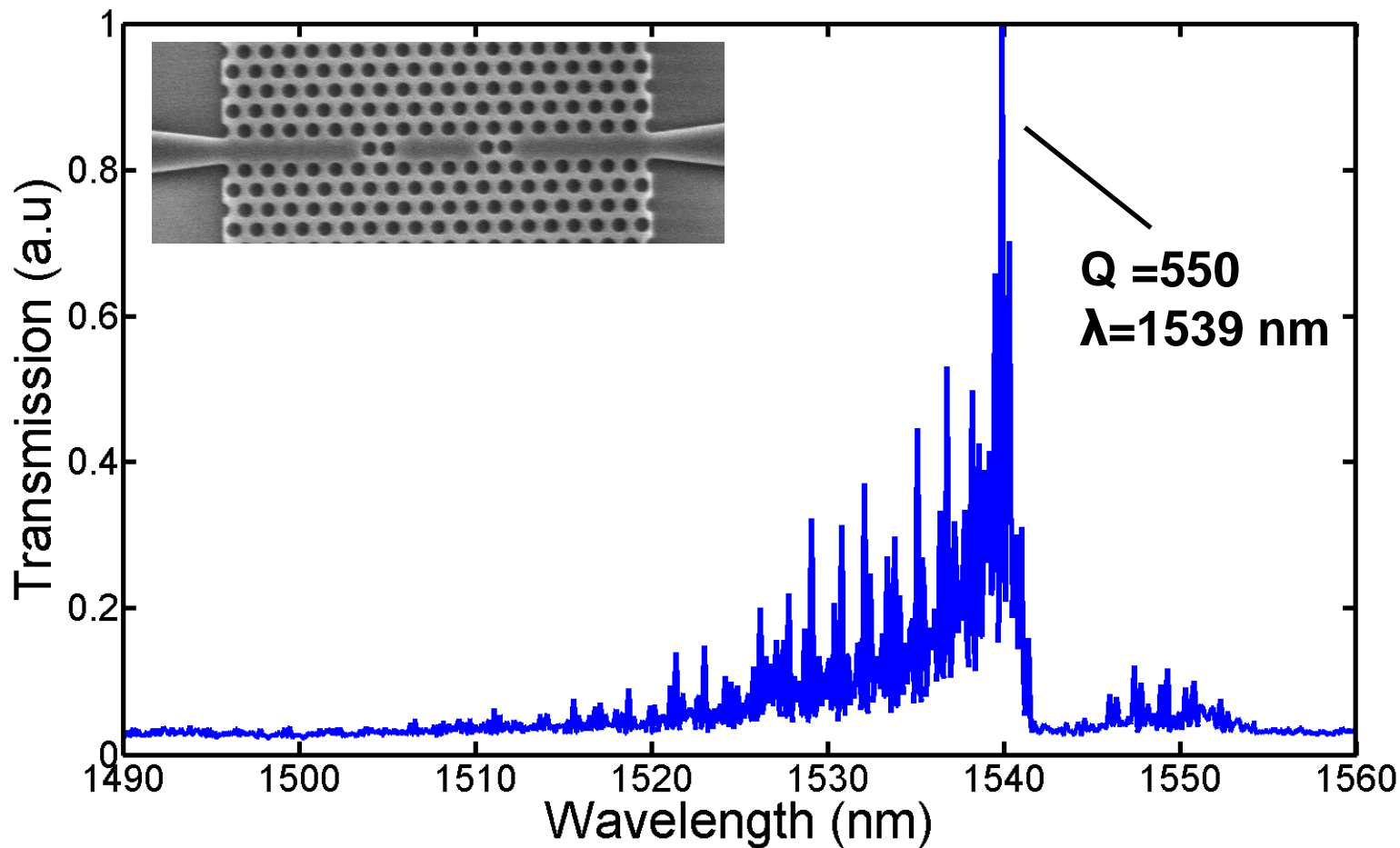
3. Design and fabrication

- For operation at ~ 1550 nm
- Lattice constant $a=430$ nm
- Fabrication with nanotechnology
- SEM picture of fabricated PhC cavity



4. Transmission measurements

L3 cavity, PhC membrane (aquatic)



6. Conclusion

- **New physical sensing principles for bacteria in water: Trapping and Raman**
- **Sensing platform: Photonic Crystal cavity for field enhancement**
- **Design fabrication and measurement of a Photonic Crystal Cavity based in water**
- **For more information on the presentation please contact m.m.vanleest@tudelft.nl**

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