Cantilever Sensors for Measurement of Biopolymer Degradation

Tænk stort. Tænk nyt. Tænk grønt. Tænk biopolymer!

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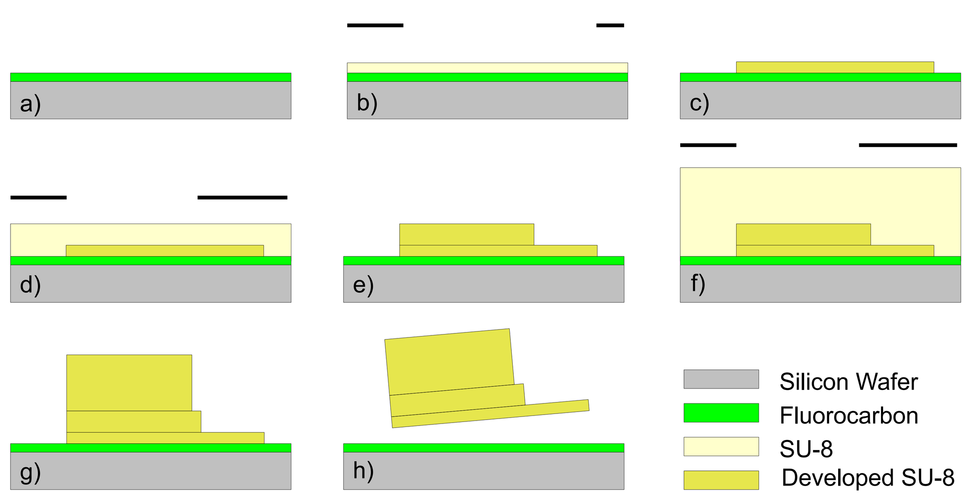
Goal: To investigate the degradation of biopolymer using a new, faster and more exact method. The investigated biopolymer is poly-L-lactide acid (PLLA) produced from corn starch or cane sugar.

It is an environmentally friendly material, which is degraded naturally by enzymes. It can replace synthetic polymers such as plastic.

The overall steps:
- Fabrication of cantilever sensors
- Spray-coating of biopolymer
- Degradation and frequency measurements

Step 1: Fabrication of the Microscopic Cantilever Sensors



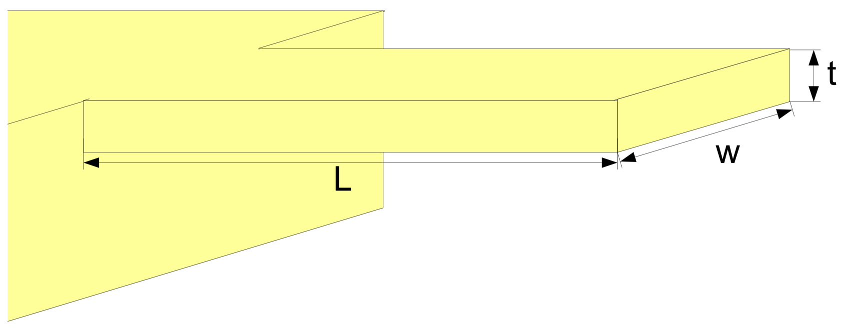
Overview of the fabrication process of the SU-8 cantilever sensors.

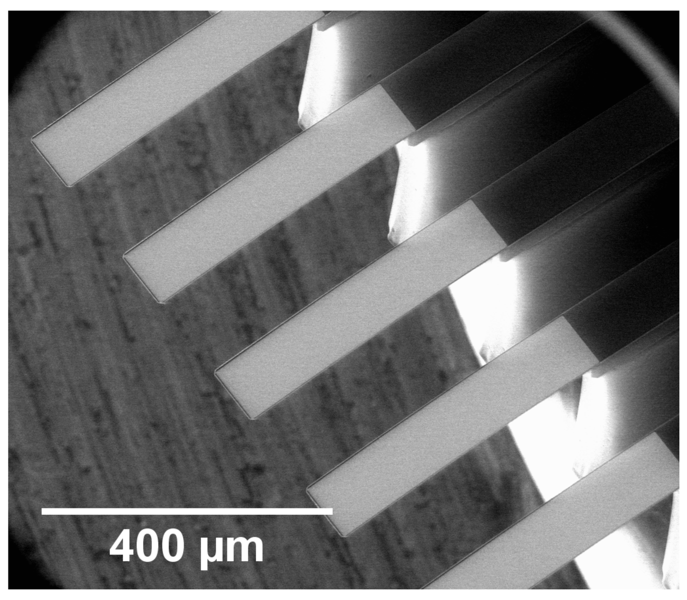
The central formula for resonance frequency

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k_{eff}}{m_{eff}}}$$

f_n is the resonance frequency, k_{eff} is the effective spring constant, and m_{eff} is the effective mass.

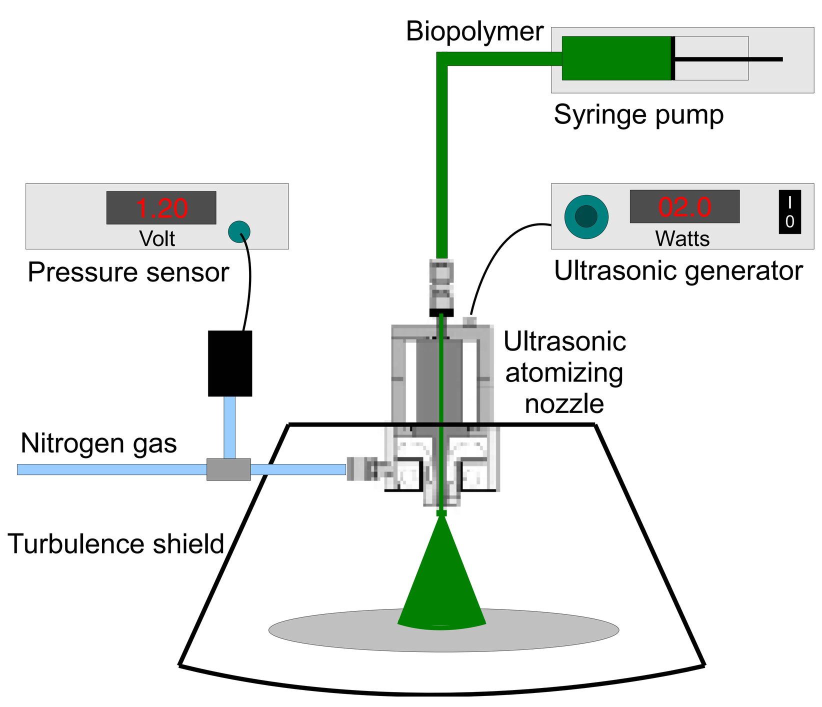
The cantilevers have a length of 500 µm, a width of 100 µm and a thickness of 5 µm.



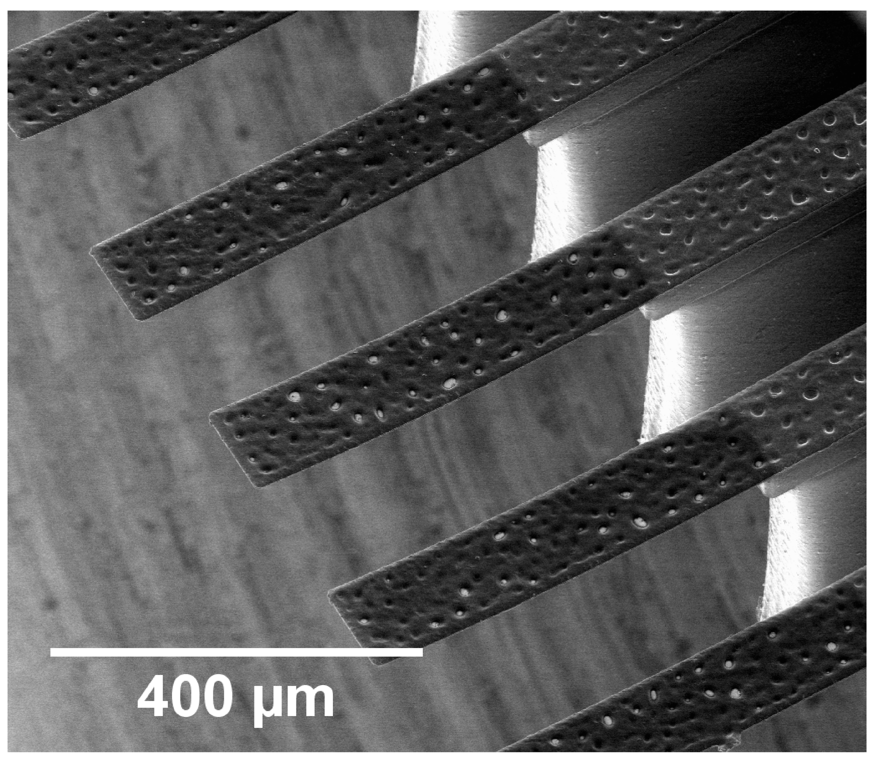


The final cantilevers.

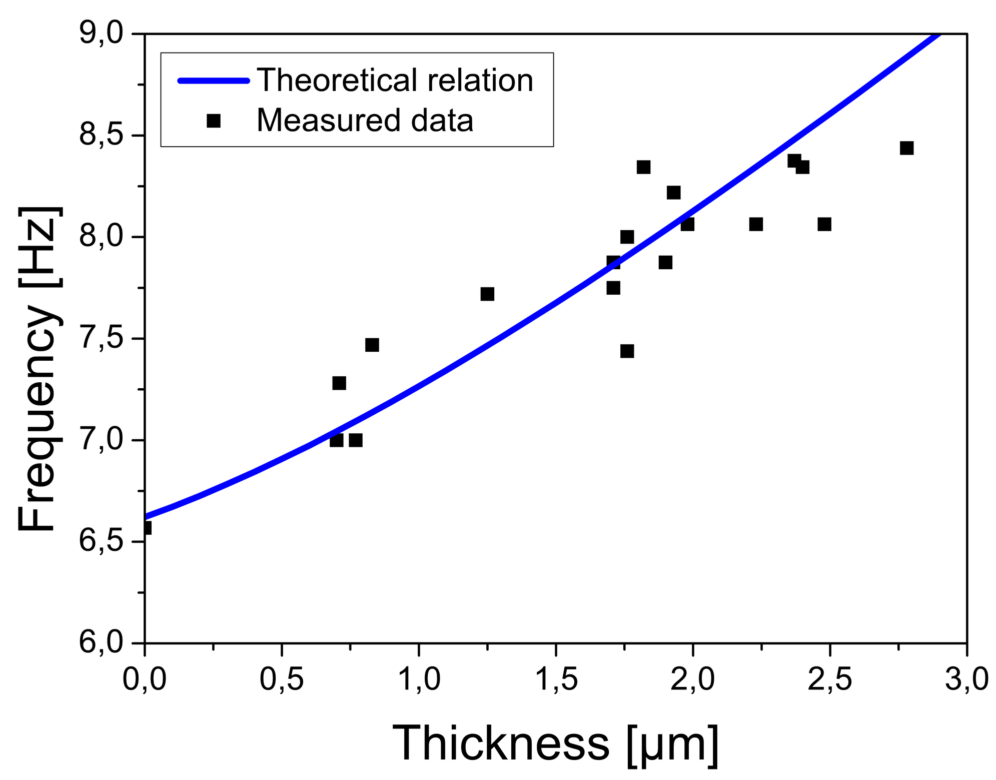
Step 2: Spray-coating of the Biopolymer and frequency measurements



Set-up with an ultrasonic atomizing nozzle.

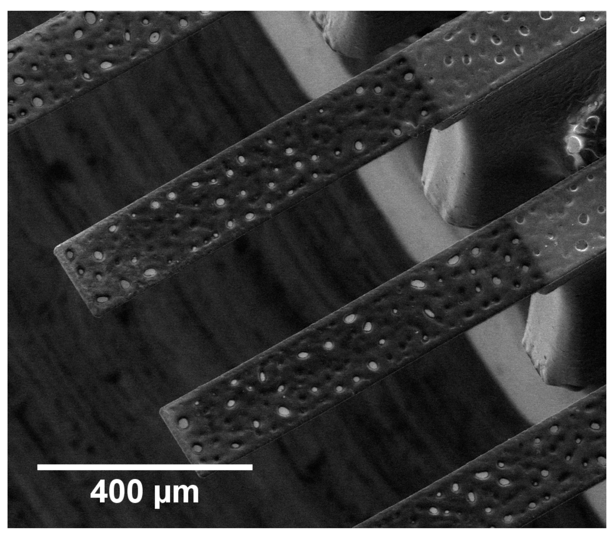


Cantilevers with a layer of biopolymer.

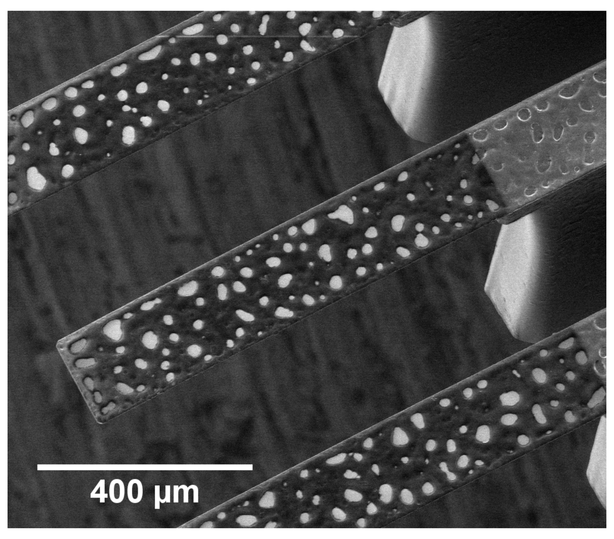


Frequency of the cantilevers vs. biopolymer thickness.

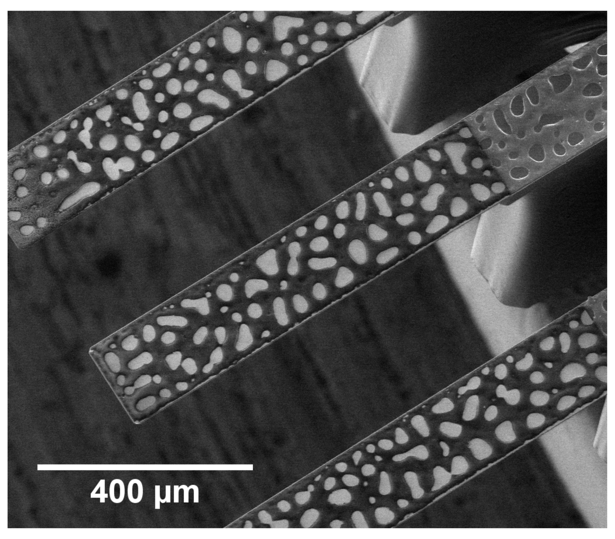
Step 3: Degradation of the Biopolymer



Degradation time 2 h.

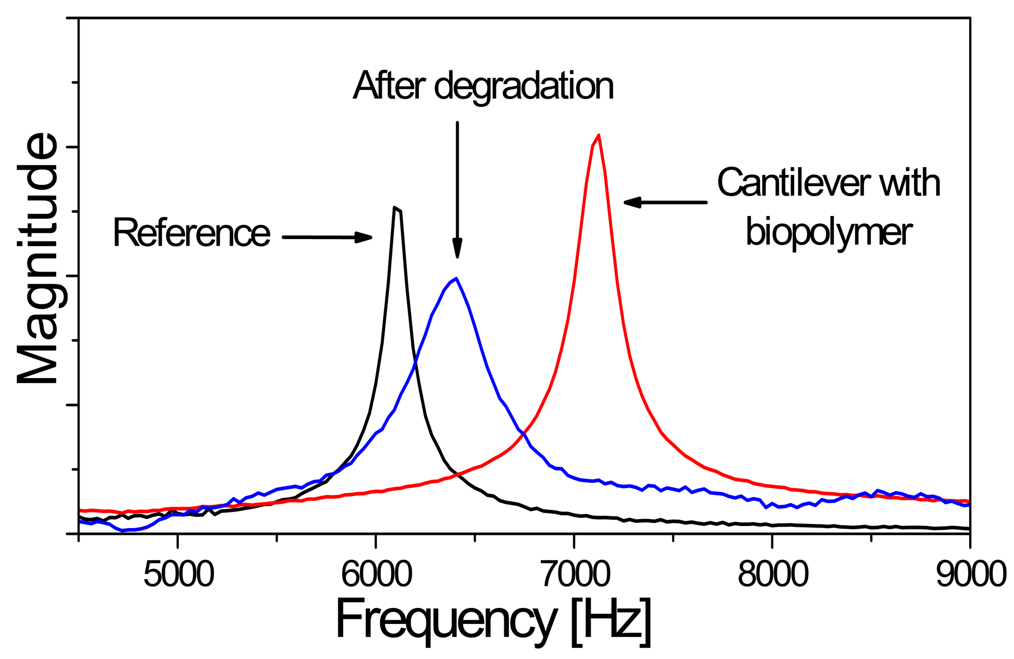


Degradation time 4 h.



Degradation time 8 h.

The degradation process of the biopolymer is observed by measuring the resonance frequency, and by studying the cantilevers in a scanning electron microscope



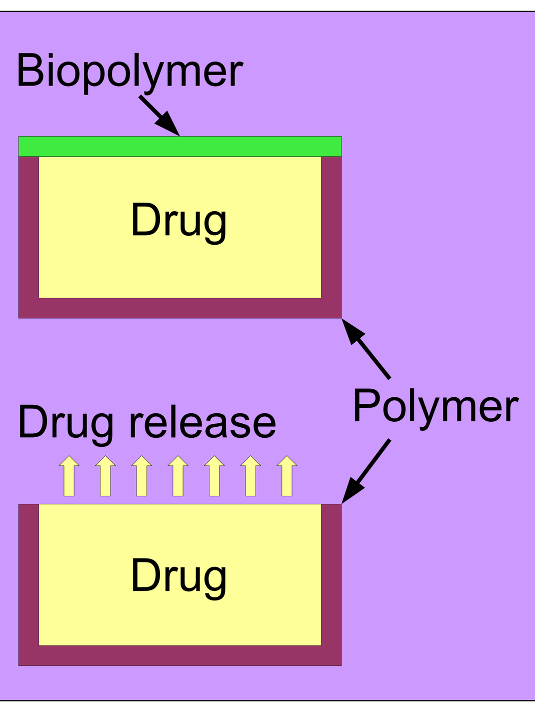
The biopolymer was degraded for various time using the enzyme Proteinase K.

The resonance frequencies was measured both for the clean cantilevers and before and after degradation.

Conclusion:

The new method is very promising for measuring degradation of biopolymer on a microscopic scale.

The method is faster and more precise than those used today!



Future Prospects:

The method can e.g. be used to make biopolymer lids on microscopic medicine boxes. This can reduce the amount of medicine, making it more efficient and decreasing the risk of secondary effects.