Future piezoresistive silicon microprobes for fast roughness measurements with high damping

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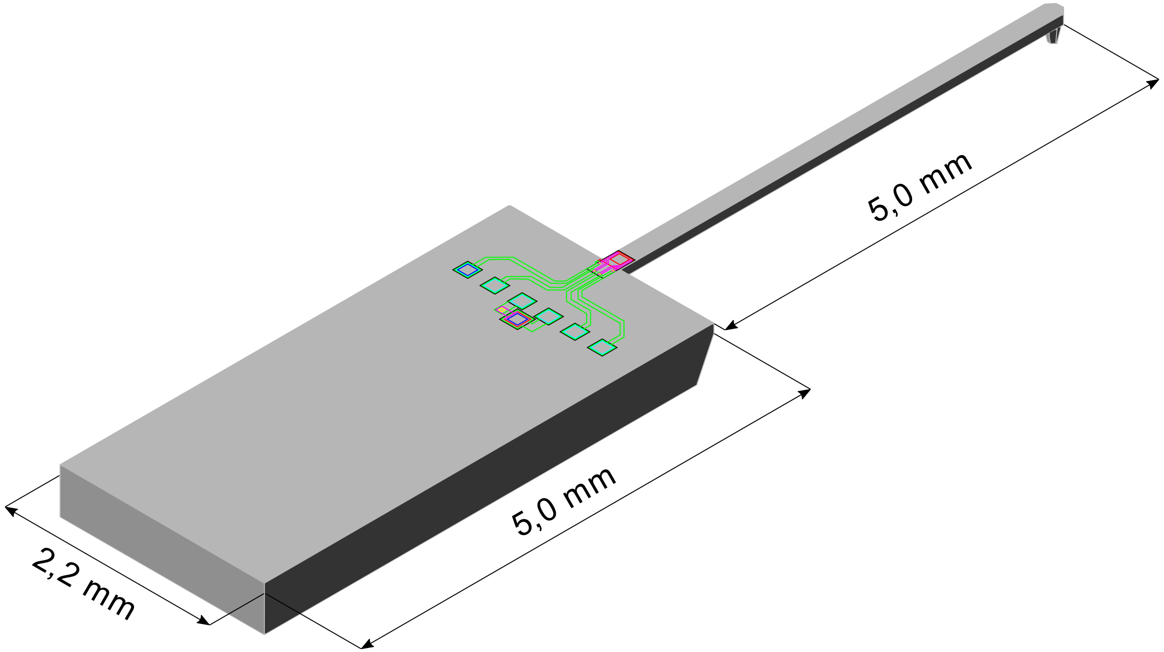
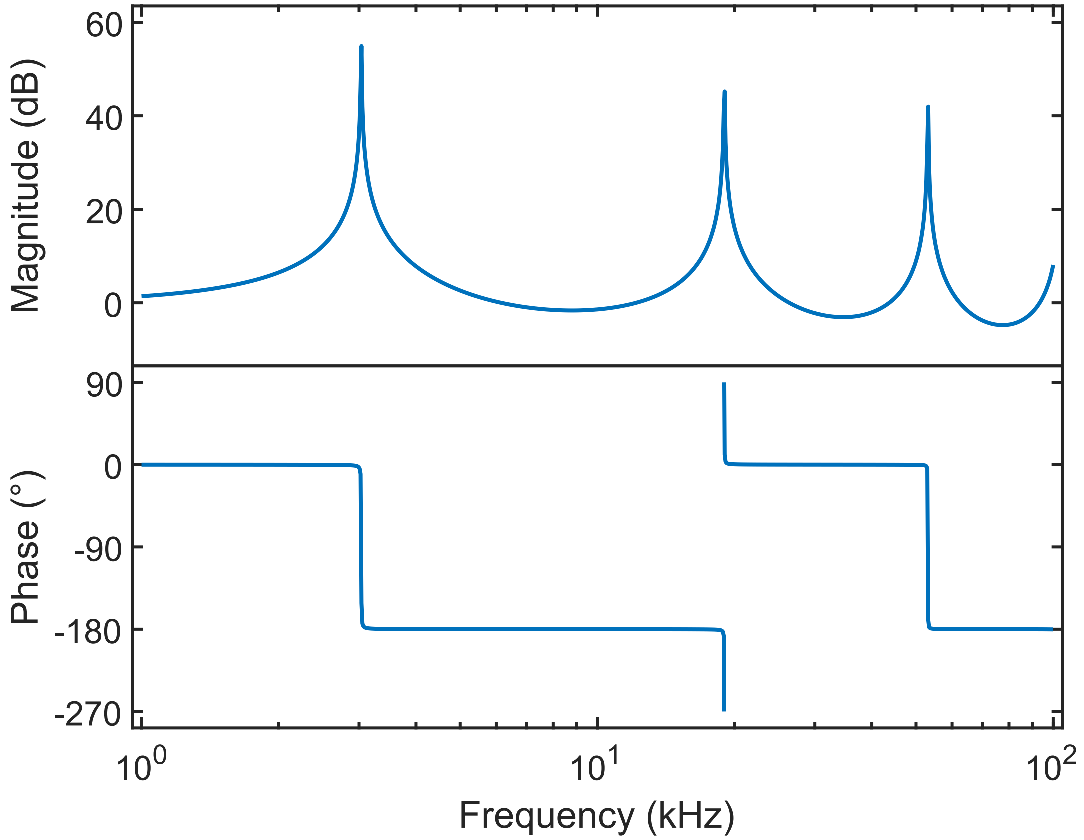
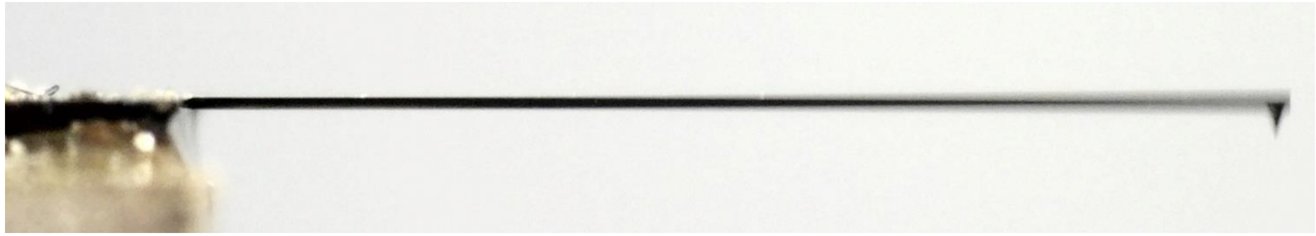
Introduction

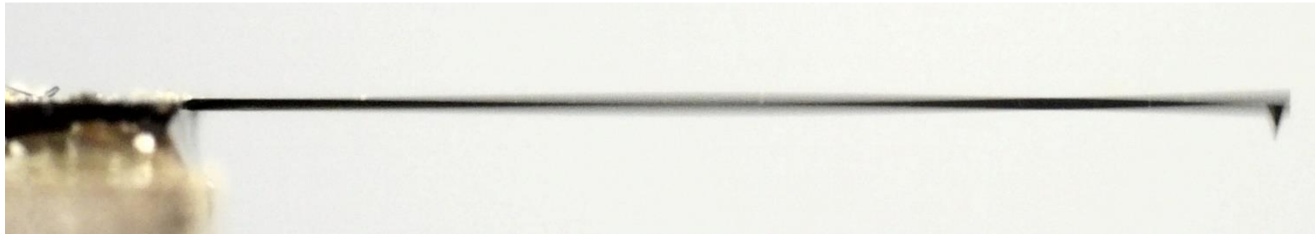
- Commercial Sensors by CiS Forschungsinstitut für Mikrosensorik GmbH
- 5 mm long, 200 µm wide and 50 µm thick
- Developed for high-speed form and roughness measurements
- Measurement range of ± 200 µm



Cantilever in air

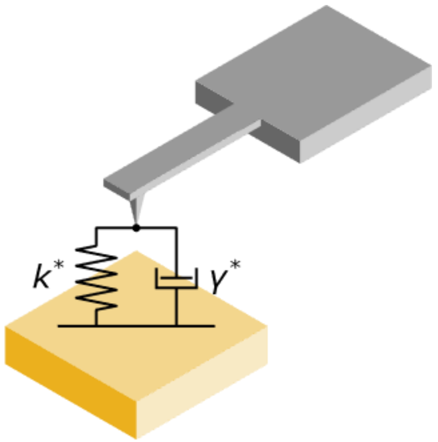


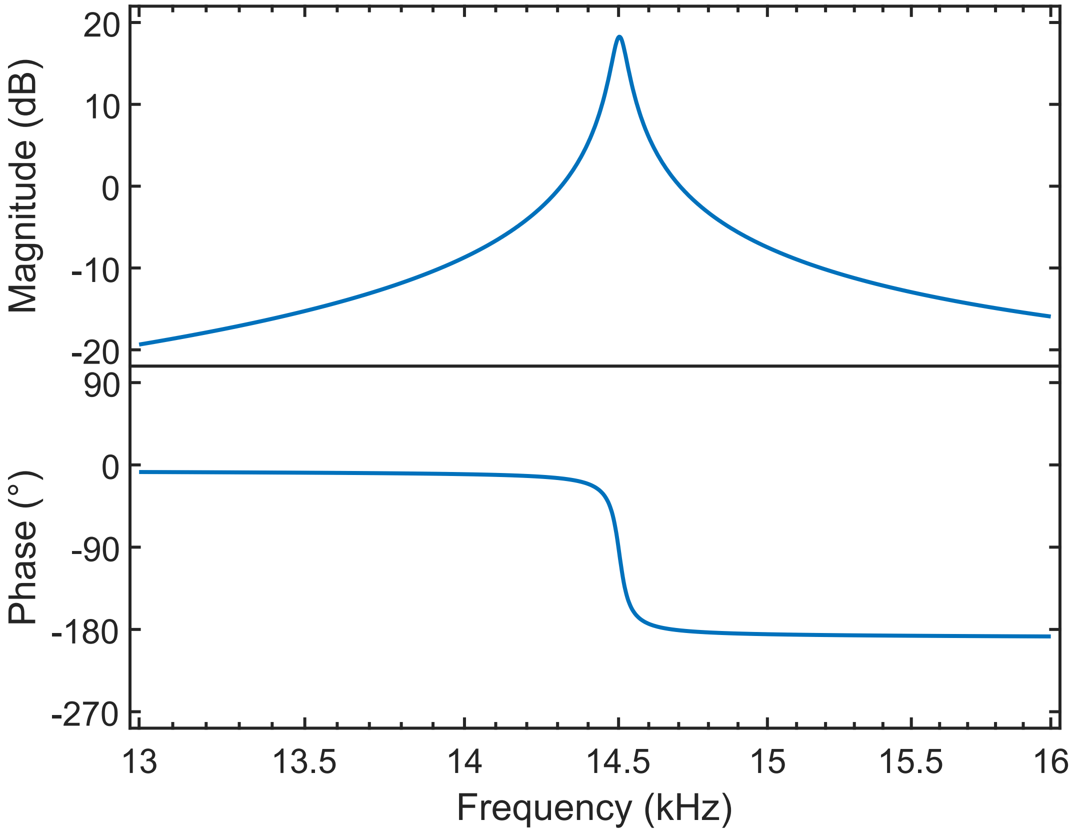




Contact mechanics

- Dynamic interaction between tip and surface can be modelled as a spring-damper-element
- Low damping on elastic surfaces
- Surface roughness limits measurement speed





Objectives of WP 2

- Damping using a layer of high-loss-module material or active *Q*-factor control
- Predeflection
- Self-actuation
- Contact resonance using a cantilever with integrated actuator

Polymer damping layer

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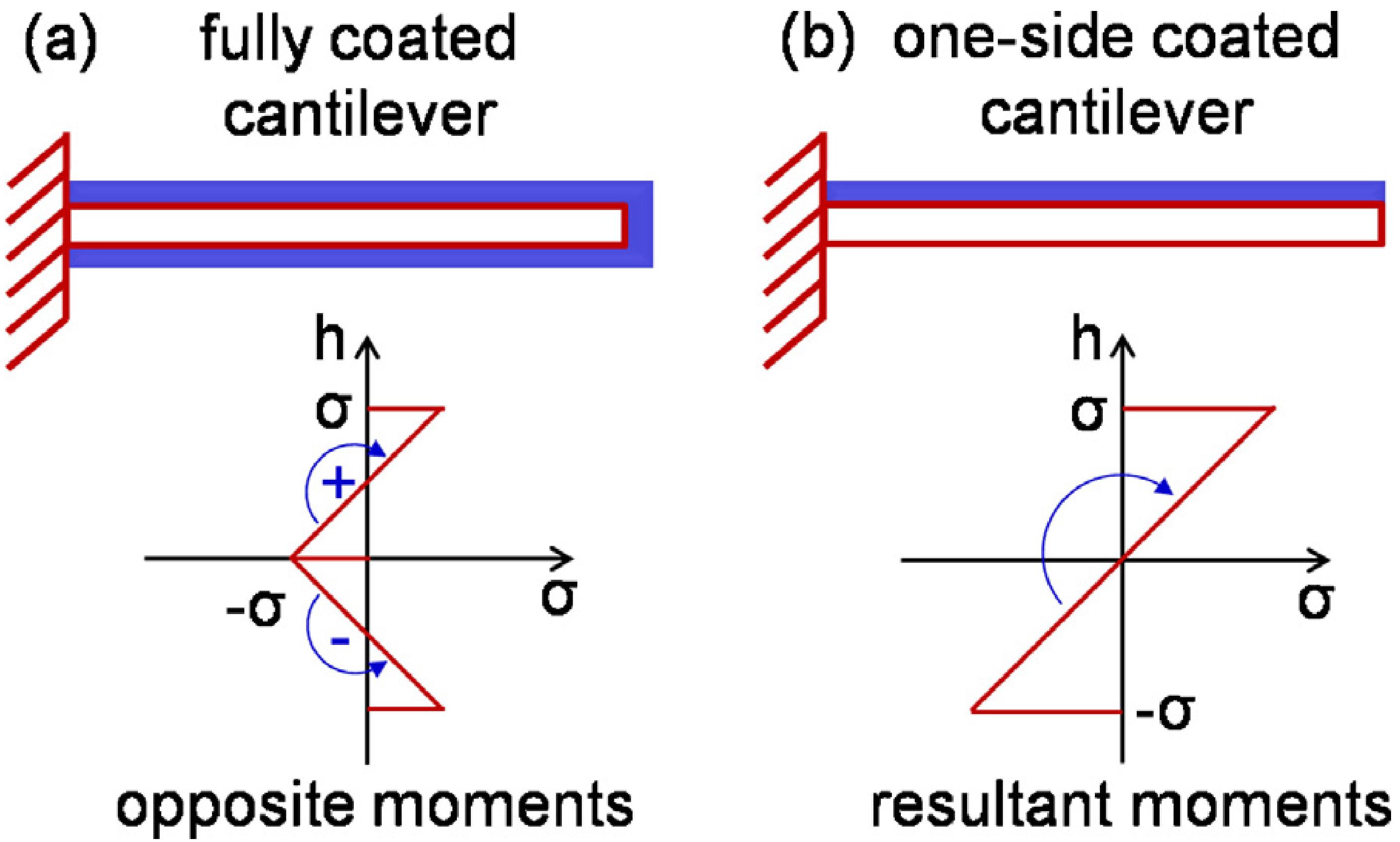
- Damping and predeflection
- Liquid or dry-film photoresist
- Layer thickness controllable through thinner and number of depositions
- Can be included in fabrication
- Has to be replaced regularly



H.S. Wasisto et al.. *Sens. Actuators A: Physical* **202** (2013) 90–99

Polymer deposition

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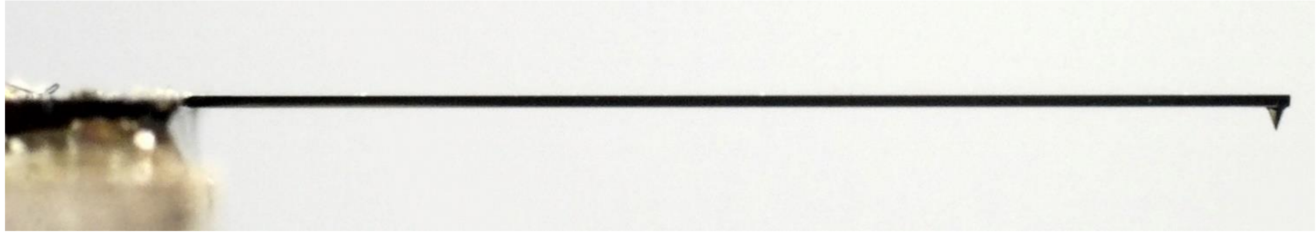
- Cantilever pushed into polymer
- 50 µm thick film deposited
- No polymer near anchor point
- Predeflection of 75 µm achieved



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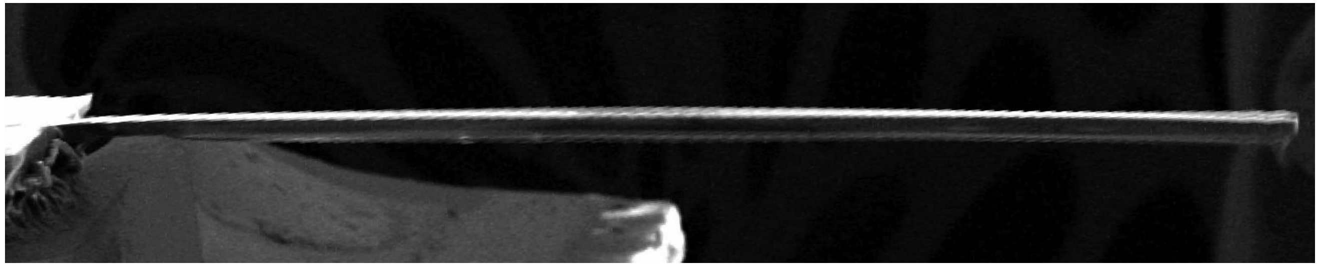
Results using polymer layers

- First resonance mode amplitude decreased by 2 dB

- Second resonance mode amplitude decreased more than 20 dB



Piezoelectric damping layer

- Passive damping, predeflection, excitation and active damping
- Material: AlN, AlScN
- Predeflection controllable through sputtering temperature
- Requires much effort to deposit
- High temperatures can harm the electronics of the sensor
- Only thin films possible

Conclusion

- Sensors need to be damped

- Damping using a polymer
  - Also creates predeflection
  - Increases damping of second vibration mode dramatically
  - Needs to be replaced regularly

- Damping using piezoelectric layer
  - Also creates predeflection and serves as integrated actuator
  - Can be used for active damping
  - Worse passive damping than polymer layer