A5(E)

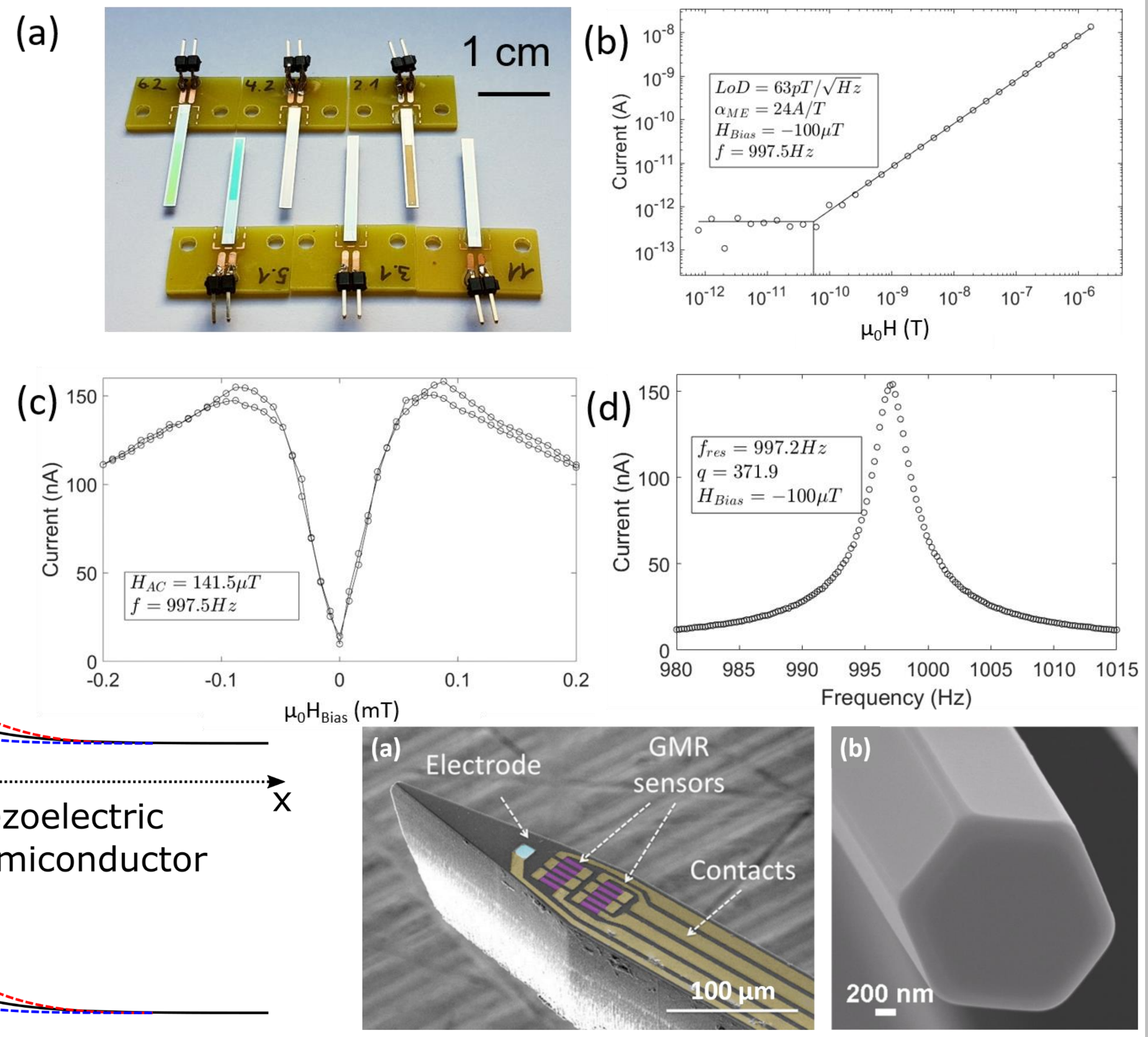
Piezotronic magnetoelectric composites

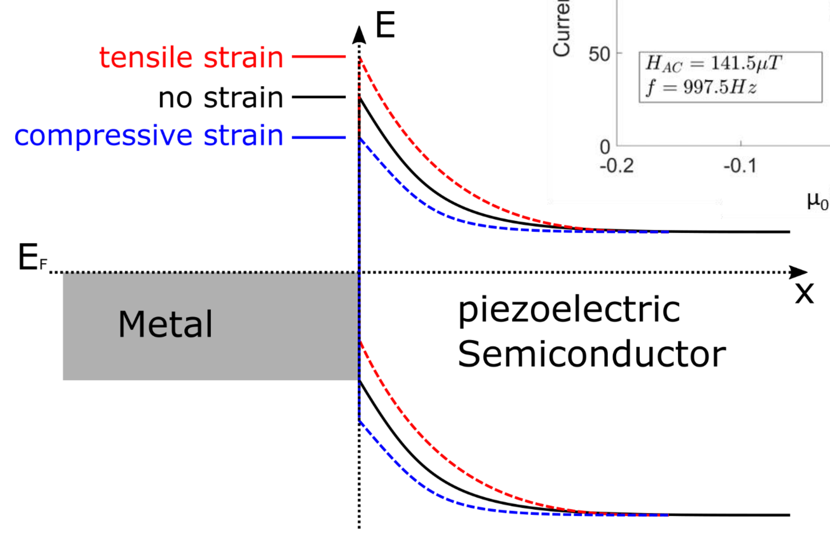
Rainer Adelung

Objectives and Original Planning

Current based magneto electric sensor with internal amplification

Schottky barrier height is affected by the piezoelectric potential when strained.



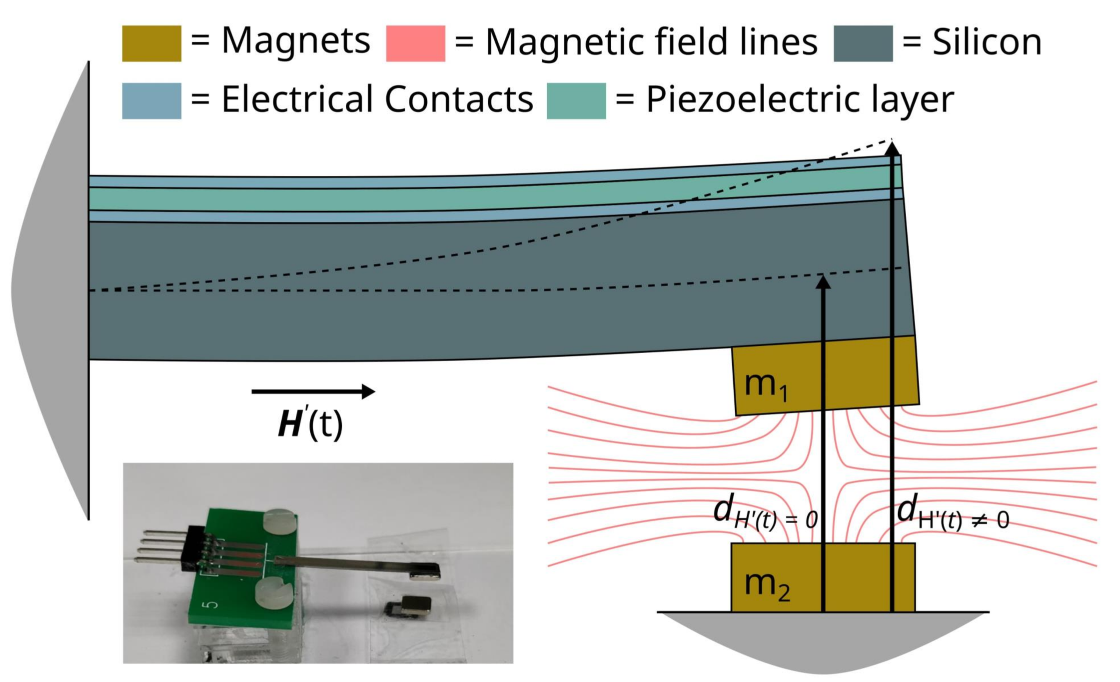


New approach: piezotronic readout

Main objectives: characterization and improvement of sensor, improve electrical noise

Research Plan Changes

New sensor concept using permanent magnets



[A5 -1]

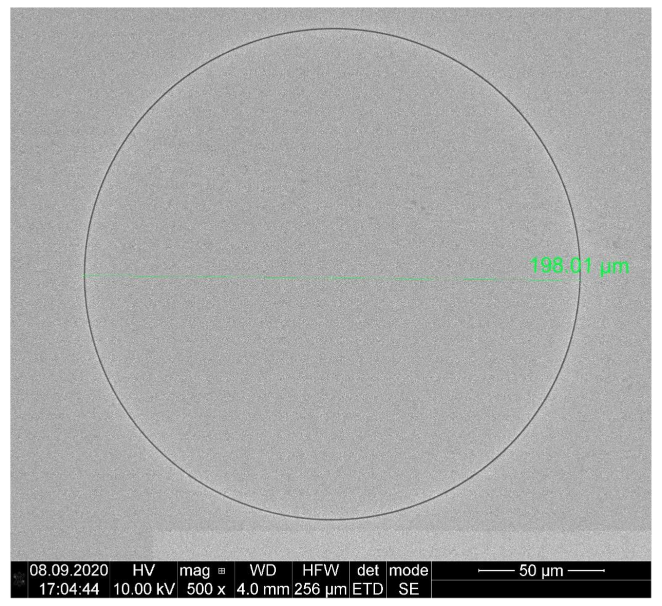
- Opposing permanent magnets are superimposed with external field
- Distance between the magnets changes with application of external field
- Readout via piezoelectric layer

- Reduced magnetic noise (thermal noise, domain movement)
- Magnetic history irrelevant for a permanent magnet
- No bias field needed
- Can be combined with various readout techniques

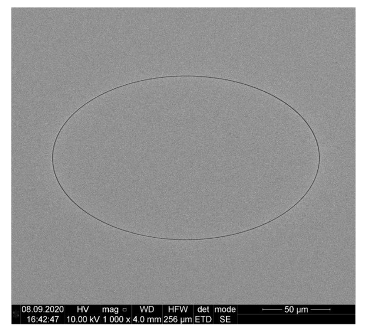
Results

Work plan
WP1 Multiterminal Piezotronics

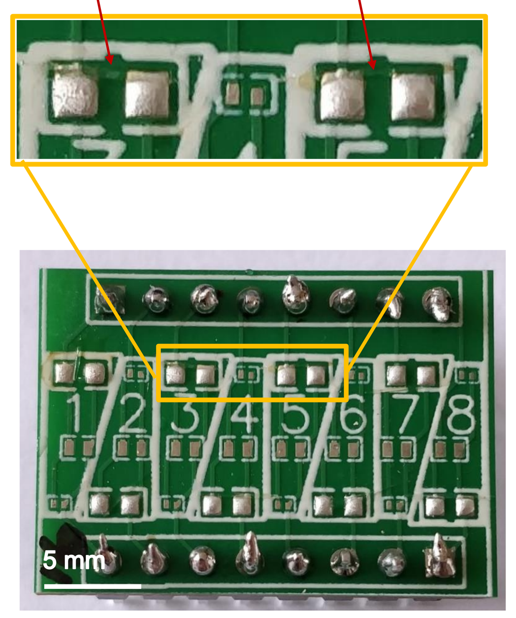
Results:
- Current flow unchanged
- Either SCR not altered or not measureably altered (not the limiting factor)



Cut of an additional (3rd) contact into electrode



WP2: Needle-shaped Sensors & WP5: Miniaturization

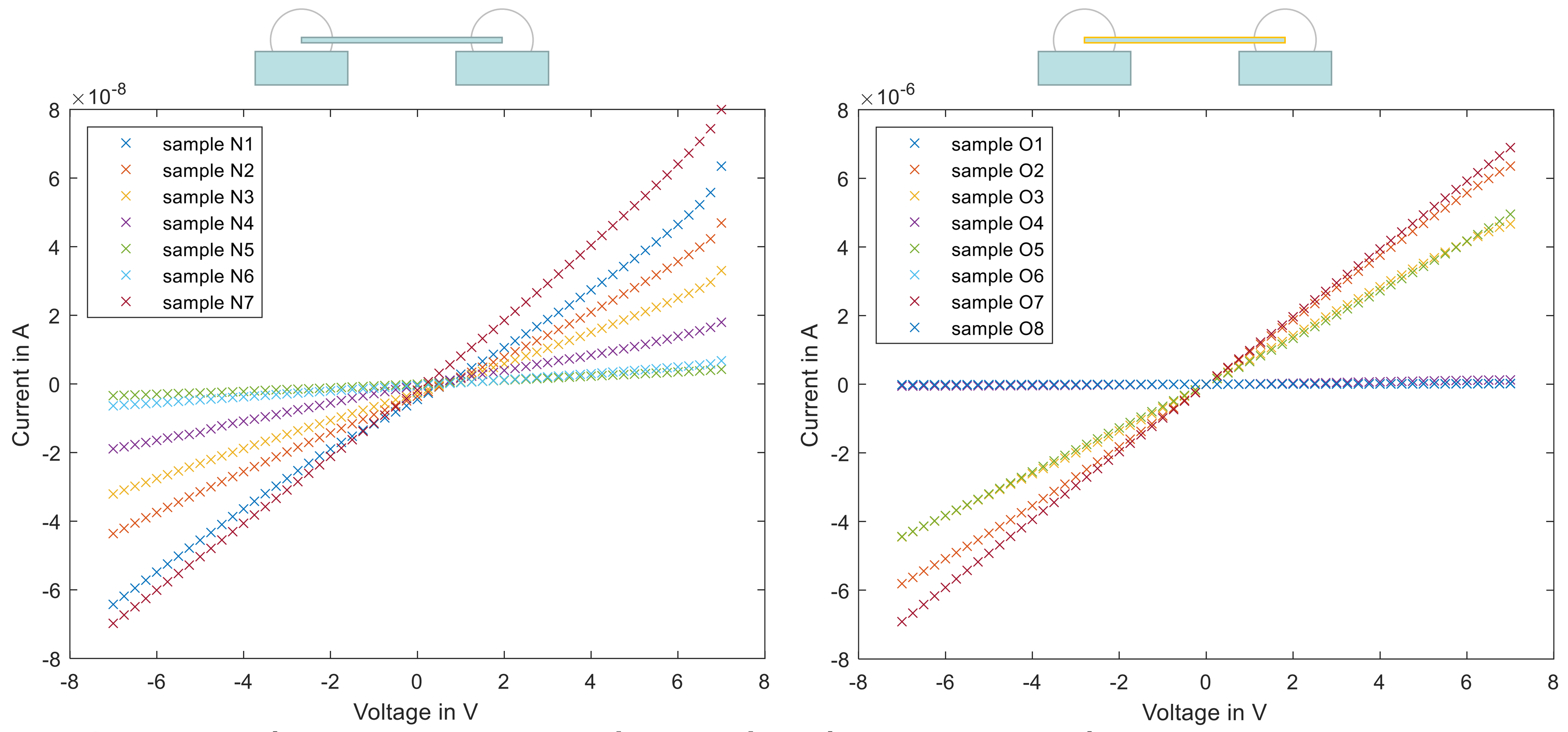


Soldered needles

Designed PCB for sample preparation and characterization

→ Use of different soldering pastes leads to primarily ohmic or primarily Schottky contacts

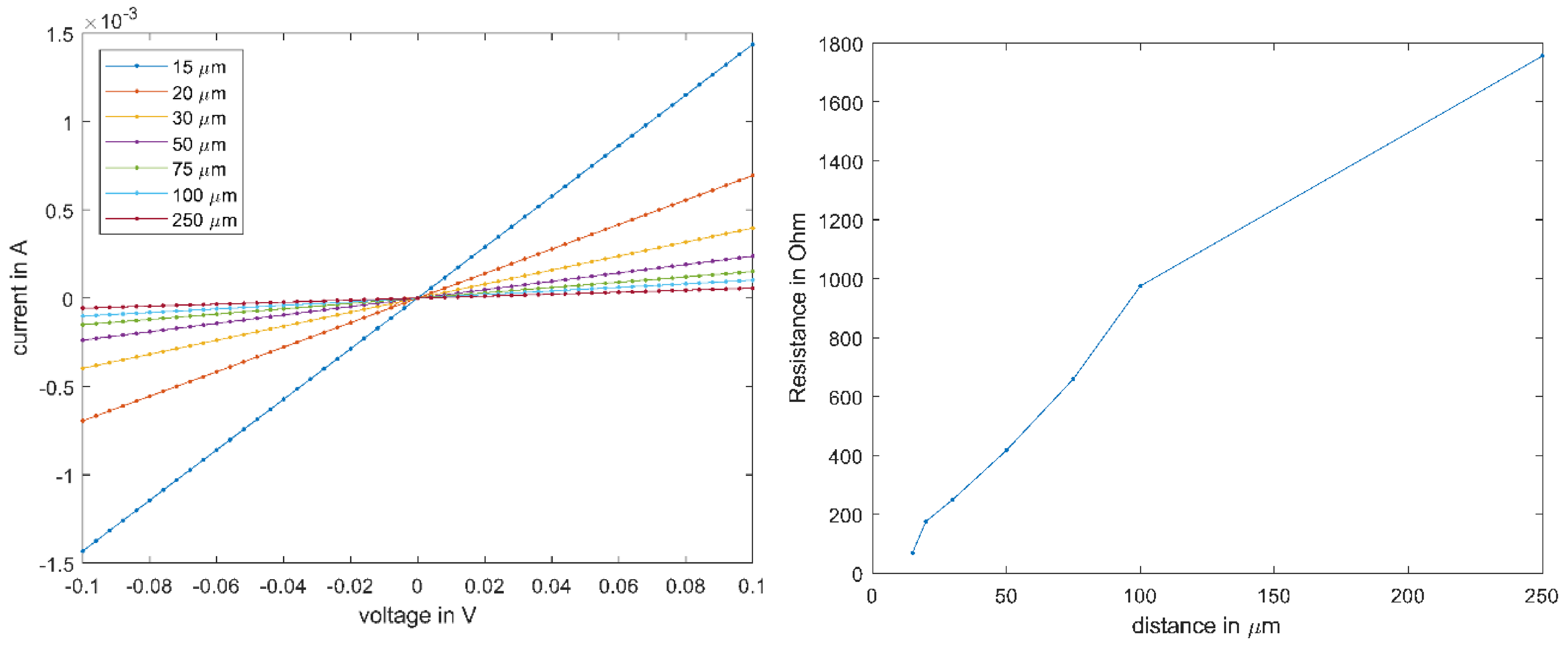
Different Oxygen Vacany Concentrations



- Symmetric contacts not always lead to symmetric IV-curves
- asymmetric contacts not always lead to asymmetric IV-curves → more defined conditions or sample preparation needed
- Results differ for different vacancy concentrations
- More defined state (freshly produced) leads to less scattering in the measurements [A5-2, A5-3]

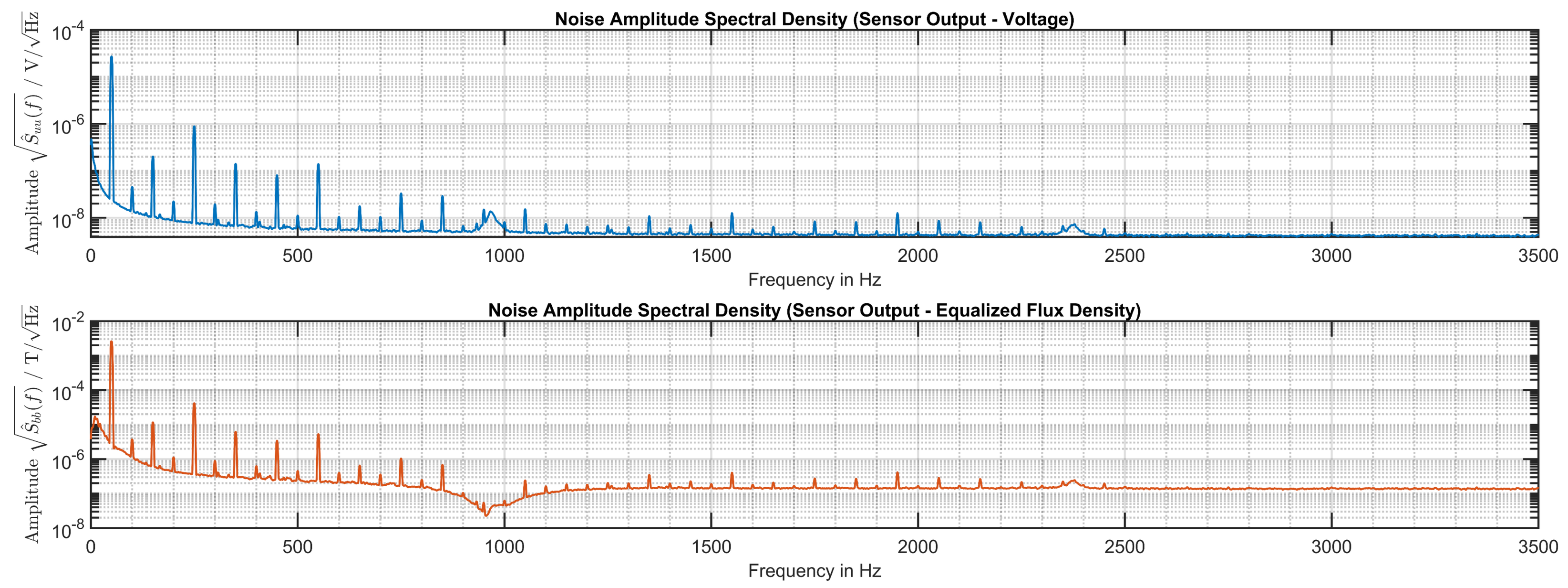
WP3 Large Bandgap Materials

AlN is used as a standard piezoelectric layer, GaN could be beneficial in use for a piezotronics sensor:
- Wide bandgap → low thermal noise
- Low defect concentration (grain boundaries) → less electric noise



Electrical characterization measurements revealed:
- ideal ohmic contacts
- Nearly linear behaviour for increasing distance [A5-4]

WP4 Characterization



Limit of Detection: 22.72 nT/√Hz in resonance at 956 Hz

In addition further electric and magnetic characterization and impedance spectroscopy were performed.

Staff Funded During Second Funding Period

Martha Gerhardt (doctoral researcher)

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