

Mechanically flexible electronics based on IGZO TFTs

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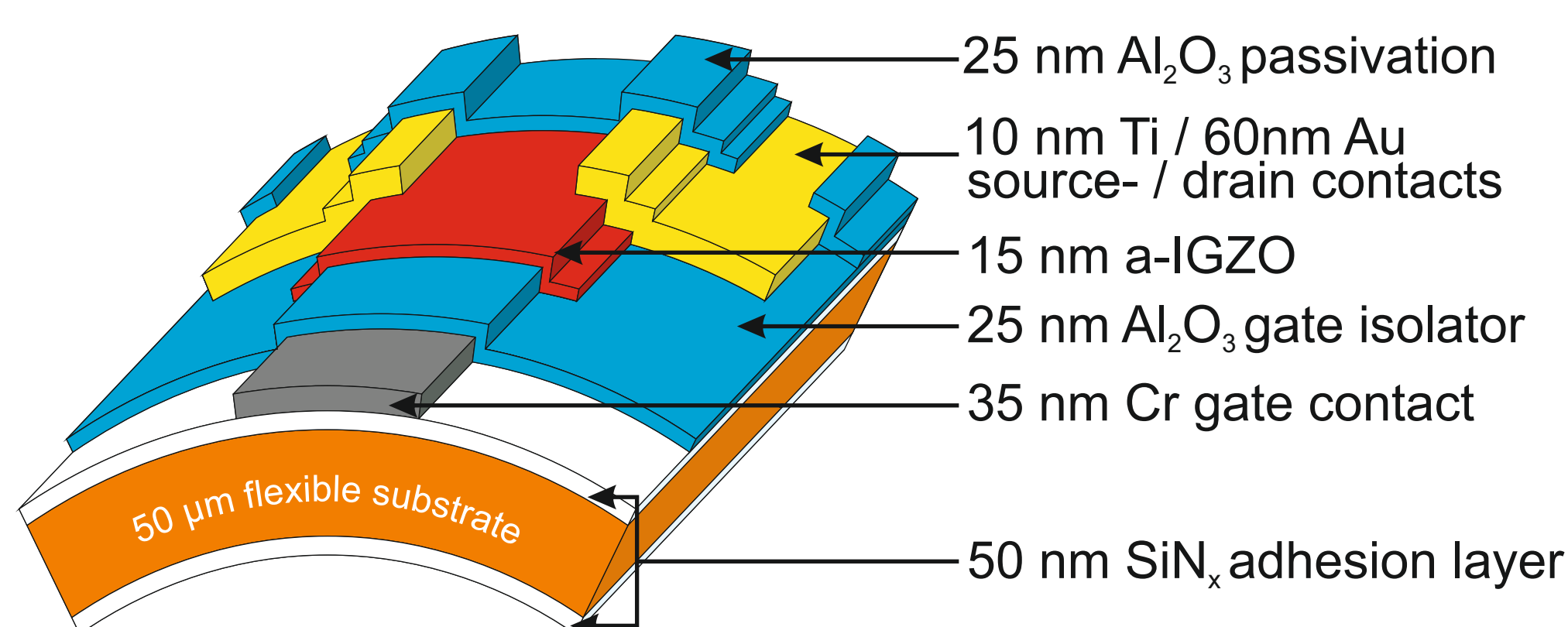
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Flexible TFTs

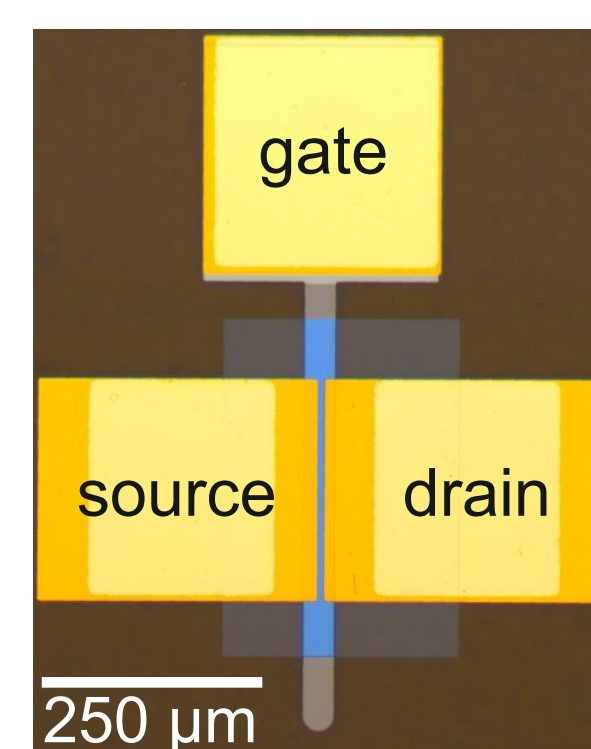
Bendable thin film transistors (TFTs) and circuits based on amorphous In-Ga-Zn-O (a-IGZO) enable applications like:

- Flexible displays and radios
- Smart textiles
- RFID tags
- Electronic skins

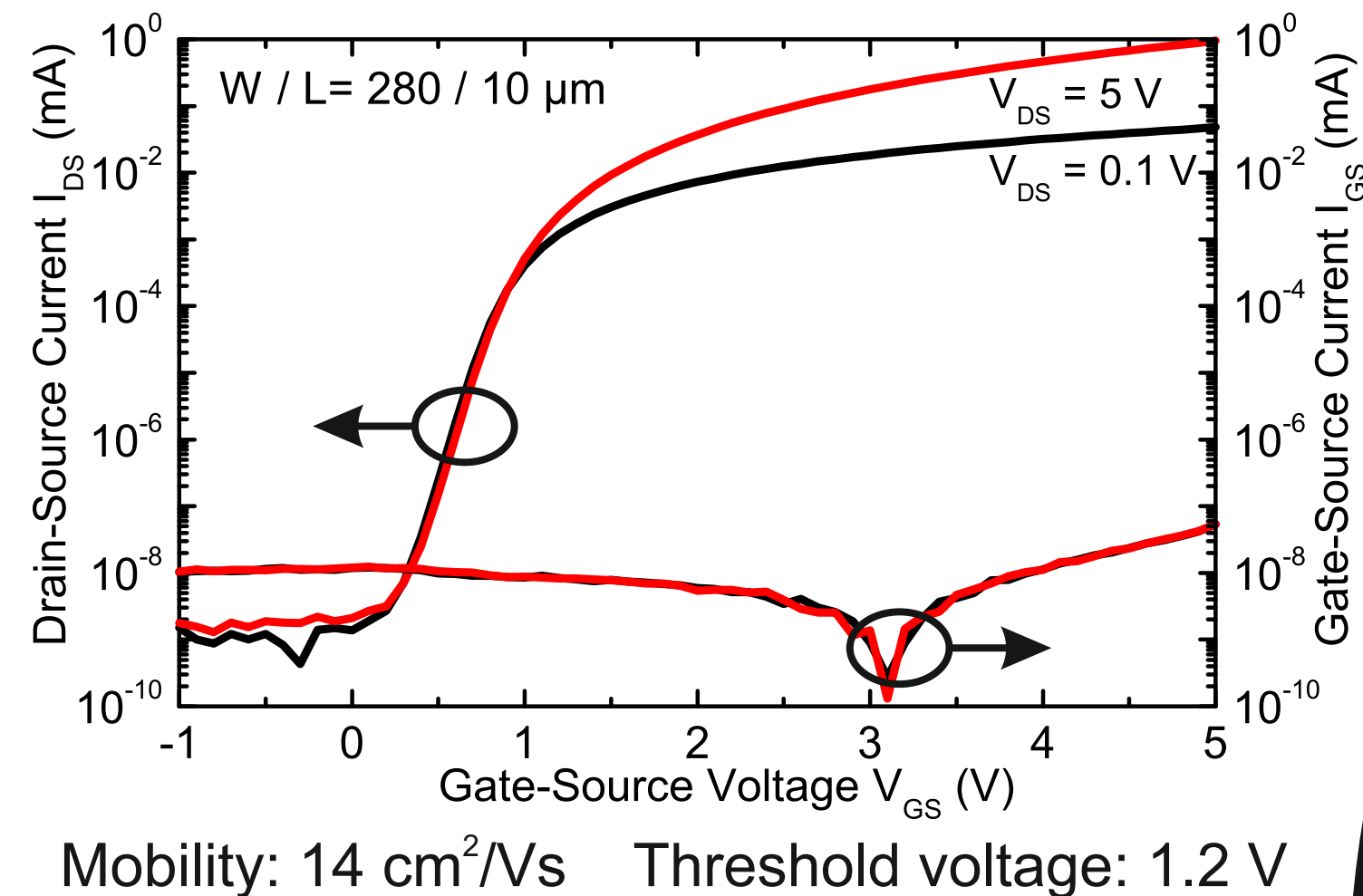
Device cross section:



Micrograph:



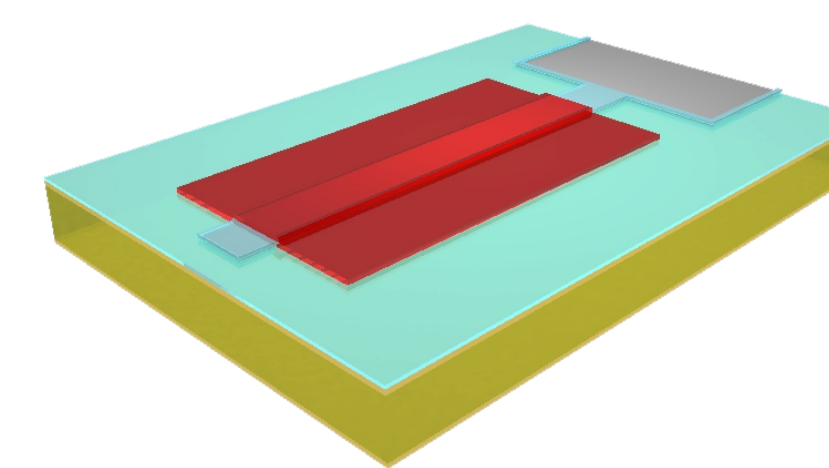
Transistor characteristic:



Fabrication

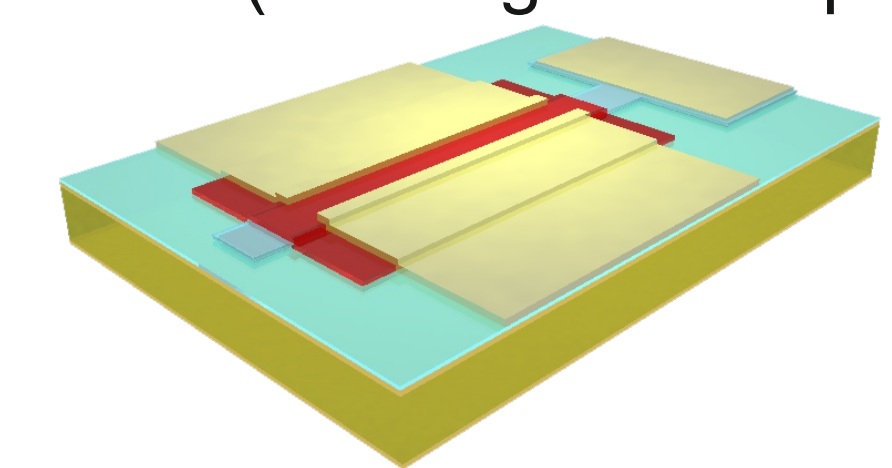
TFTs are fabricated on free standing plastic foil at temperatures <150°C

- 35 nm Cr (e-beam evaporation)
• wet etching of the gate contact

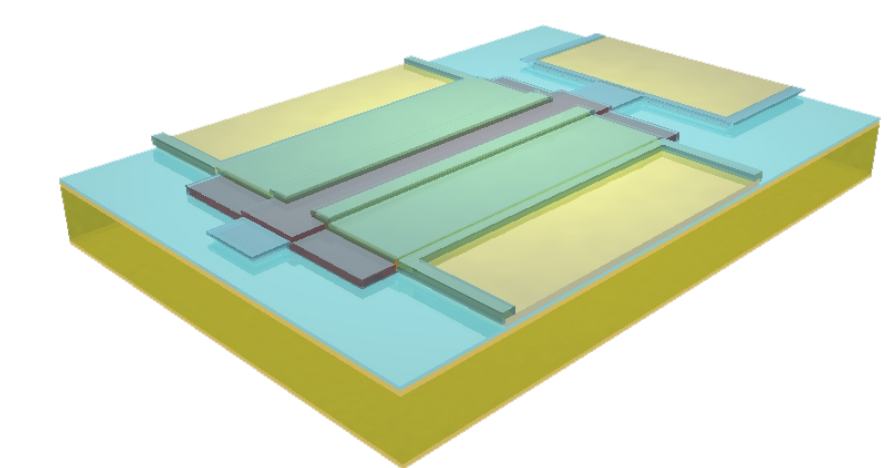


- gate isolator wet etching
• semiconductor wet etching

- 25 nm Al₂O₃ gate isolator (ALD)
• 15 nm a-IGZO semiconductor (RF magnetron sputtering)



- 10 nm Ti + 60 nm Au (e-beam evaporation)
• lift-off structuring of source and drain contacts



- 25 nm Al₂O₃ (ALD)
• passivation layer wet etching

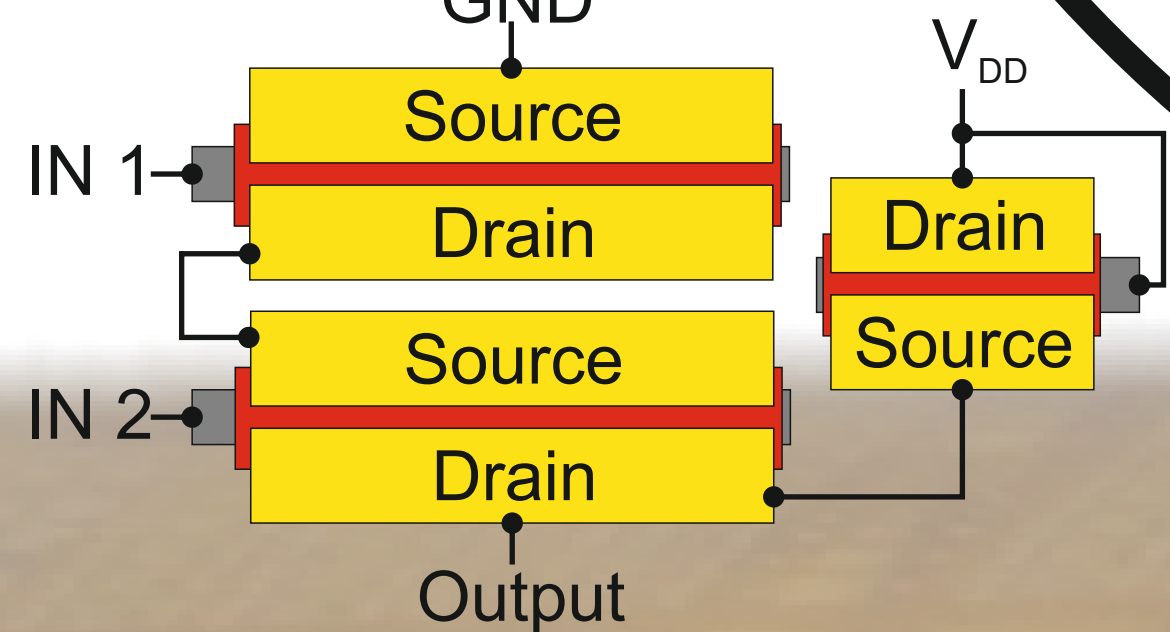
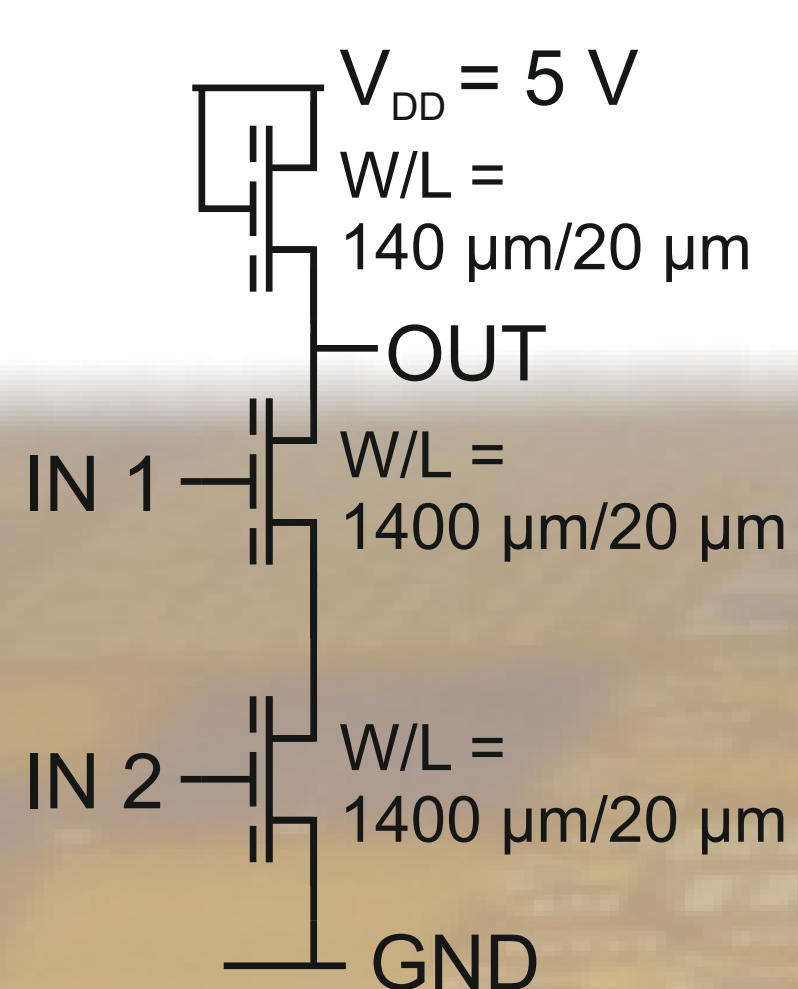
Au ■ a-IGZO ■ Al₂O₃ ■ Cr ■

Digital circuits

NAND gates build using three flexible n-type a-IGZO TFTs:

Circuit schematic:

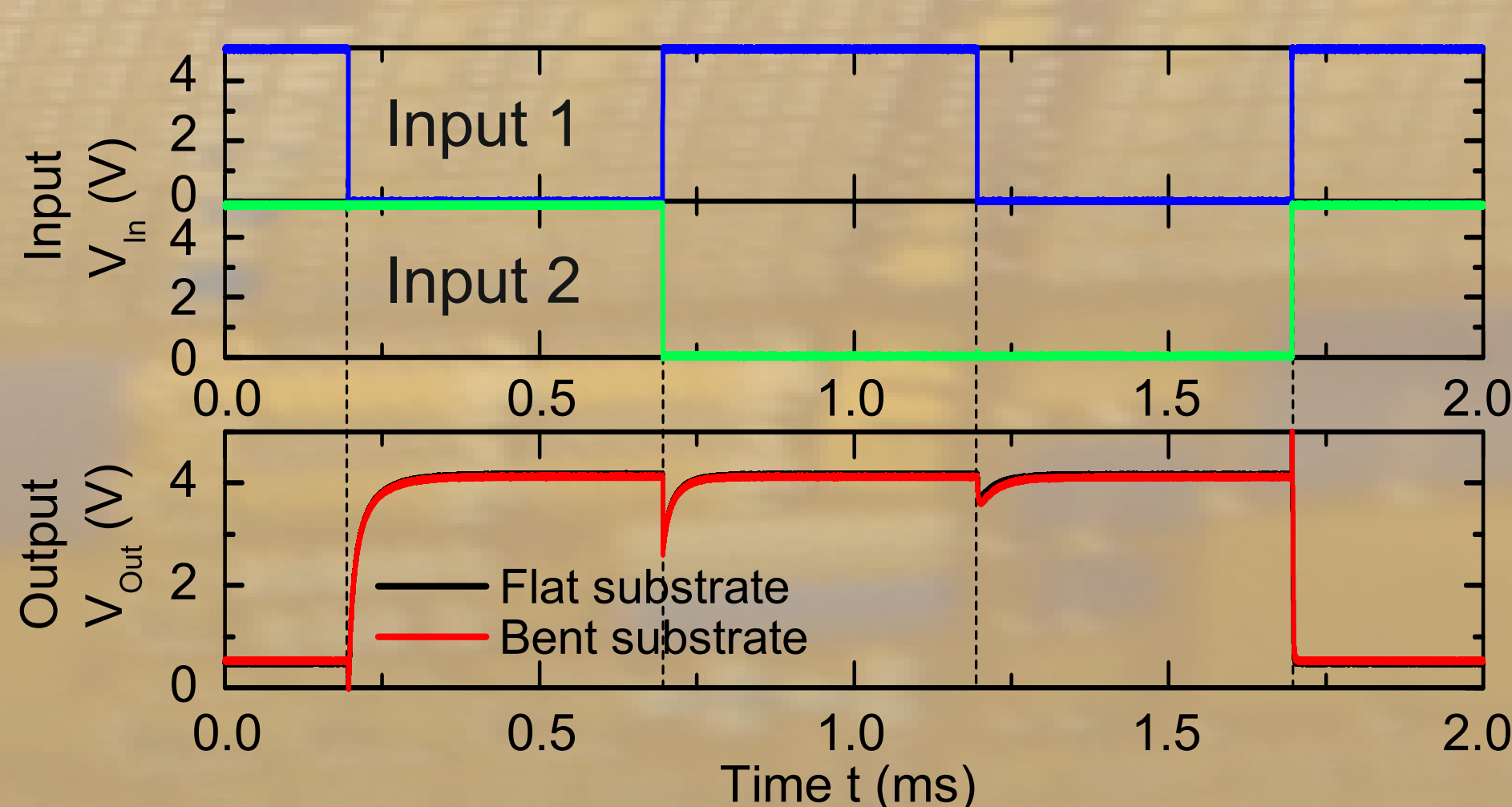
Design:



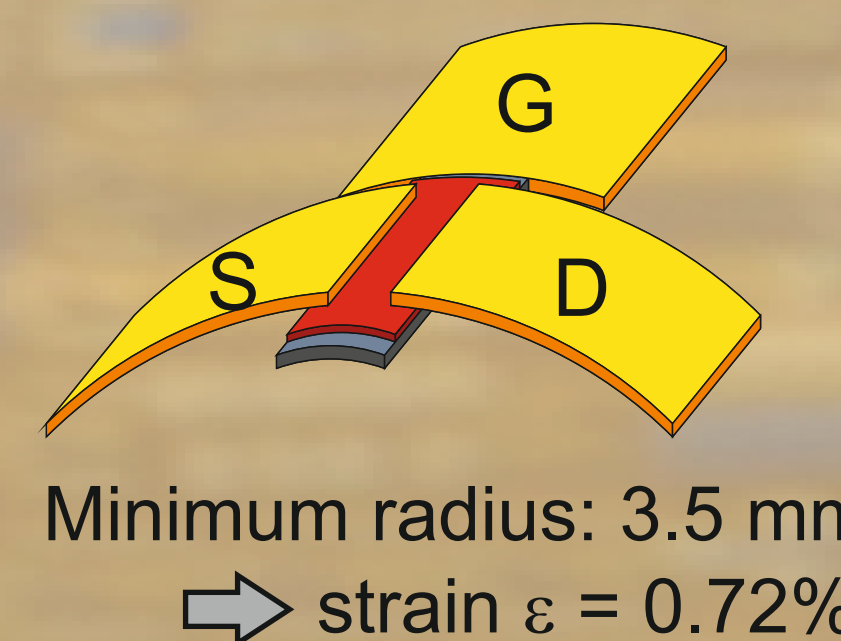
Micrograph:



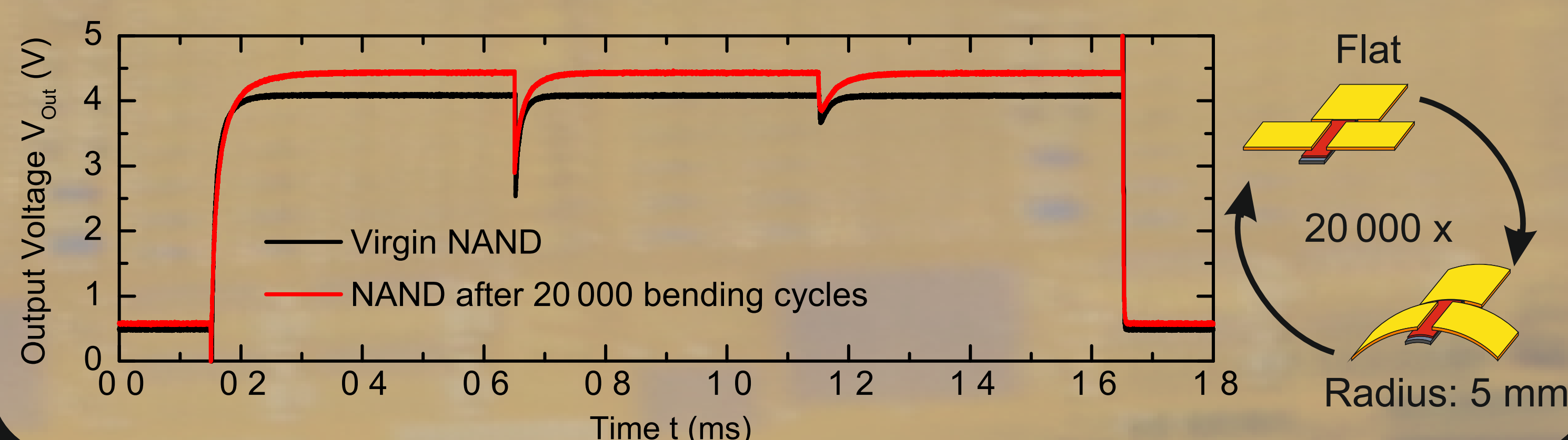
Operation under strain (r = 3.5 mm):



Tensile bending parallel to TFT channel:



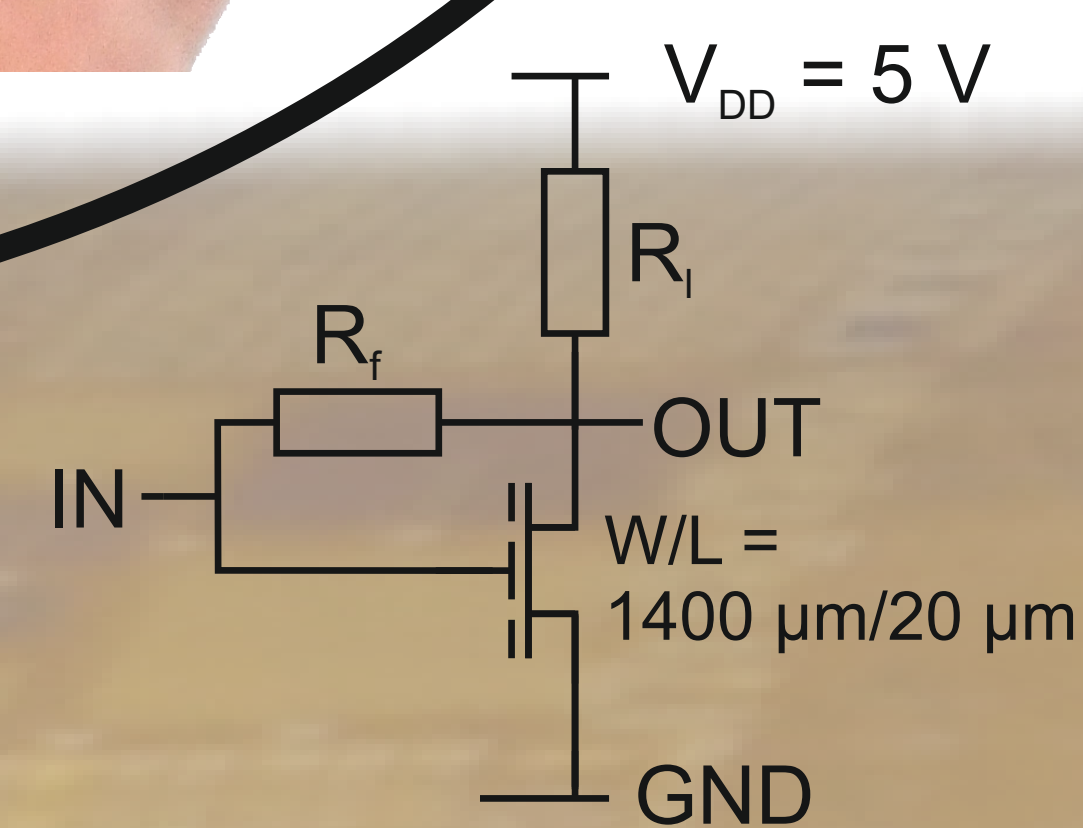
Repeated bending:



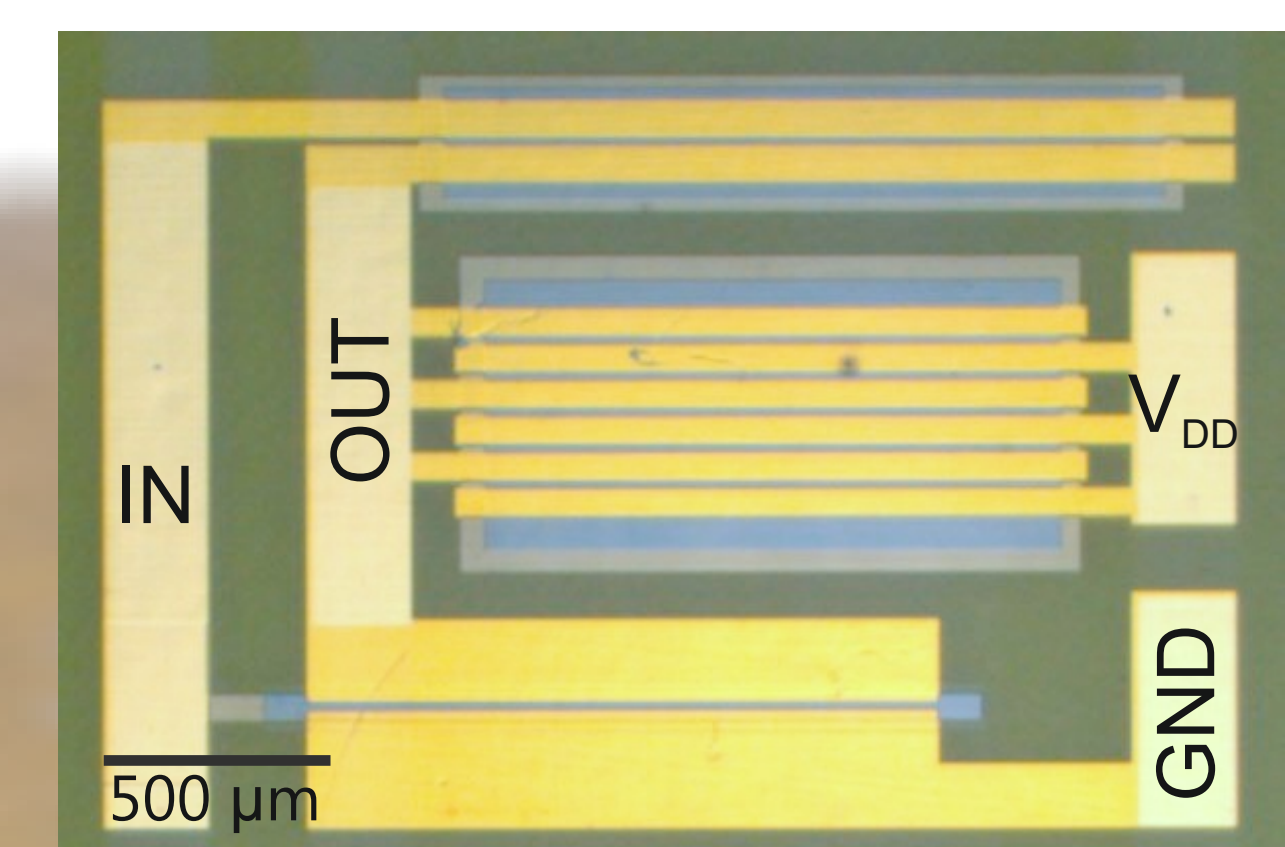
Analog circuits

Flexible transimpedance amplifier using one TFT and two a-IGZO resistors:

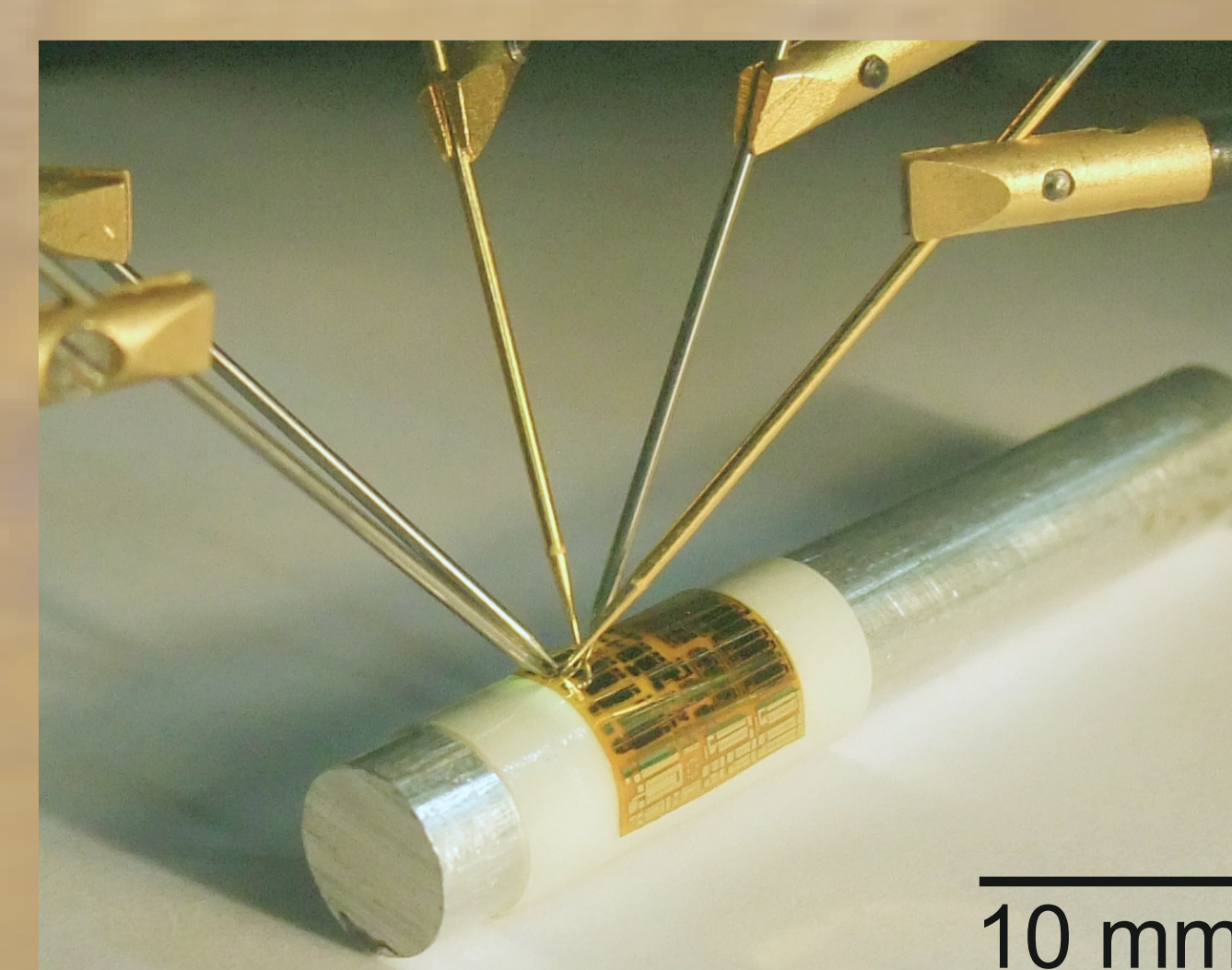
Circuit schematic:



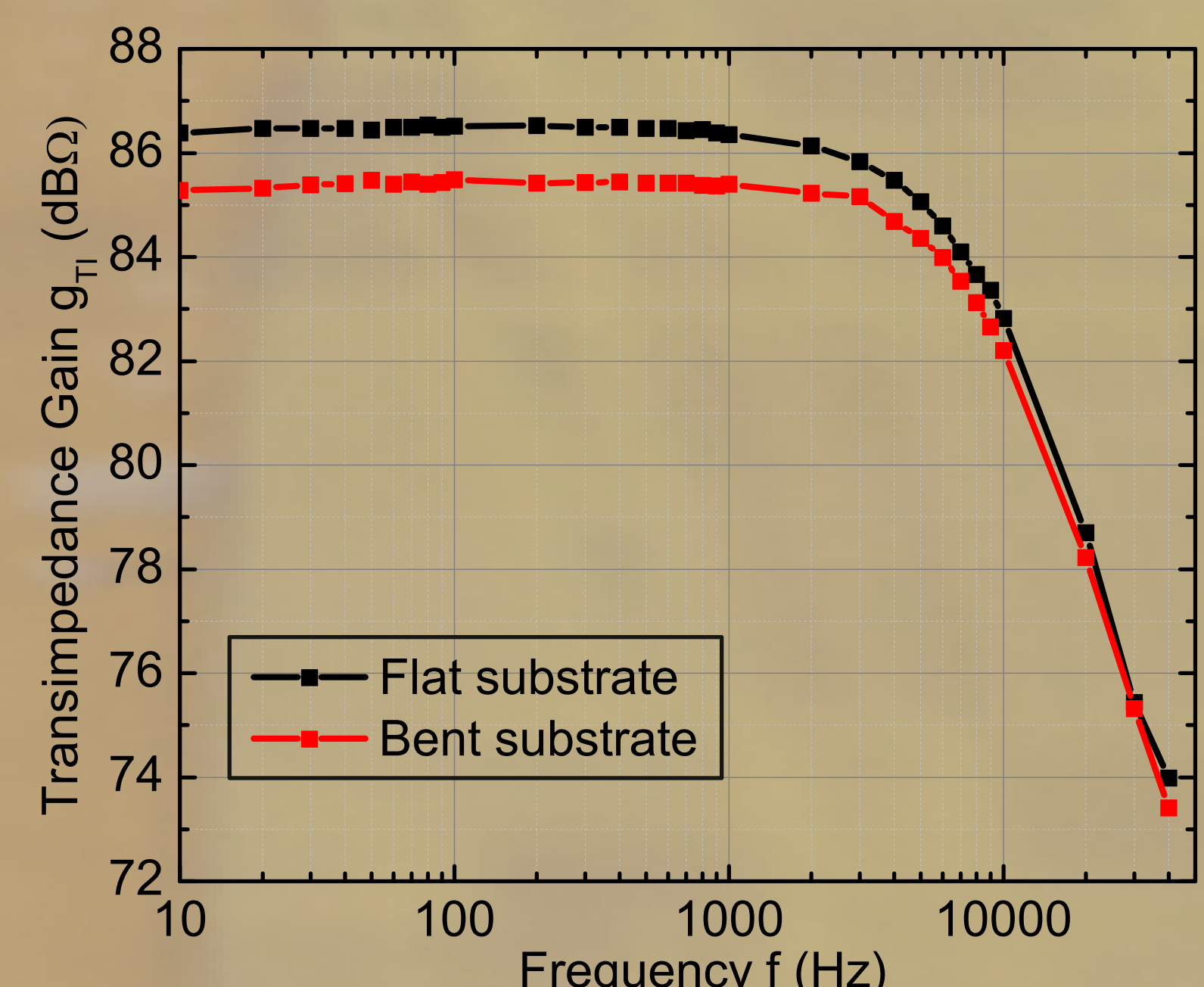
Micrograph:



Testing under strain:



Operation under strain (r = 5 mm):



- Low temperature TFT fabrication on free standing plastic foil
- Circuits are bendable to radii as small as 3.5 mm
- Circuits stay operational after 20,000 cycles of repeated bending and reflattening