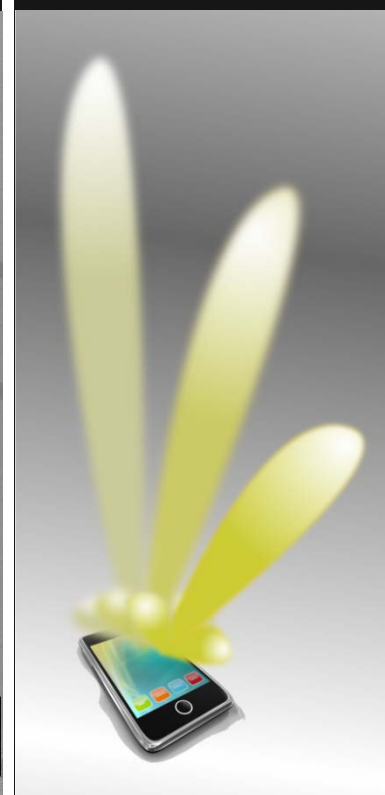
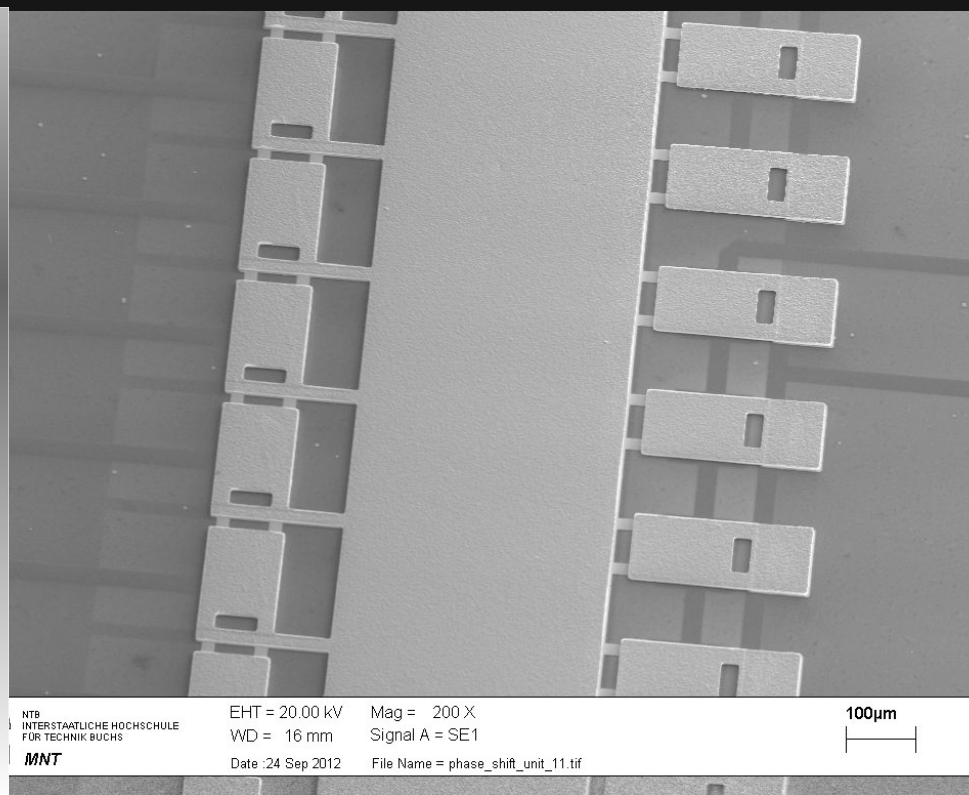


Development and Industrialization of RF MEMS



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Näher dran
am System
der Technik
der Zukunft

Content

Introduction

Innovations and their Transfer to Industries

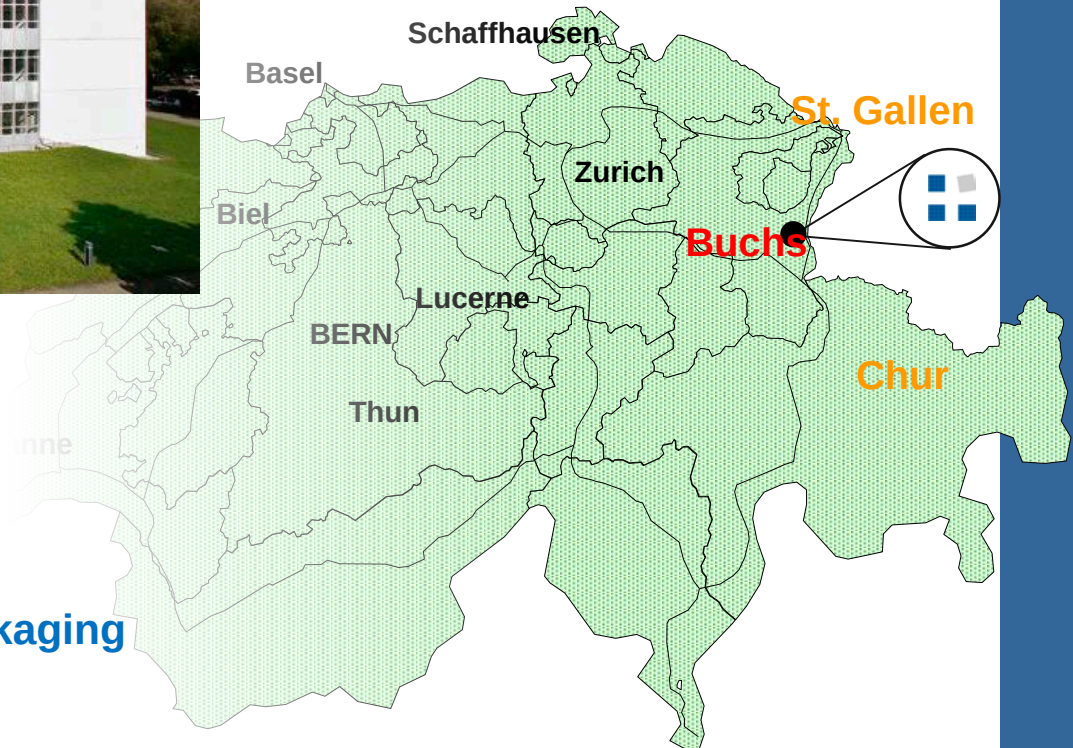
External Partners

Example: Development and Industrialization of RF MEMS

Introduction



Institute for Micro- and Nanotechnologies
Buchs, Switzerland



MEMS Group

- MEMS modelling and design
- MEMS fabrication
- Analytics and testing
- Technology transfer and packaging

Die sieben NTB Institute und ihre Kompetenzen

MNT Mikro- und Nanotechnologie

EMS Entwicklung Mechatronischer Systeme

IES Energiesysteme

ICE Computational Engineering

ESA Elektronik, Sensorik und Aktorik

INF Ingenieurinformatik

PWO Produktionsmesstechnik,
Werkstoffkunde und Optik



Institut MNT: Projekte und Partner (1)



Kunden: Unser Antrieb

- Zufriedene Kunden, die wieder kommen
- Grosses Forschungs-Netzwerk
- Langjährige Zusammenarbeiten mit der Industrie in CH, FL, D, AT, ...
- Arbeiten unter Geheimhaltung (NDA)
- Industrie-freundliche Regelung des Geistigen Eigentums

Innovation und deren Transfer in die Industrie

Marktvorteile durch Technologie

- halten
- gewinnen

Motivationsgründer für eine externe Zusammenarbeit

- Überhaupt Zugang zu F+E, wenn man selbst keine macht
- Limitierte Ressourcen erweitern
- Die Kompetenzen in einem bestimmten Feld erweitern
- Direkter Zugang zu Innovation

Was bedeutet Technologietransfer?

- Zusammen mit der Industrie transferieren wir Forschungsergebnisse in effiziente Fabrikationsprozesse.
- Zusammen mit der Industrie implementieren wir neue Technologien in bestehende oder neue Produkte.

Externe Partner

Vorteile bei einer Zusammenarbeit mit externen Partnern

- Externe Partner unterstützen die Industrie mit ihrem spezifischen Know-how.
- Kann die Firma mit zusätzlicher Manpower unterstützen
- Kann der Firma helfen, ein neues Produkt zu entwickeln mit gegebenen Anforderungen und definierten Schnittstellen.
- Kann die Firma mit einer unabhängigen Expertise unterstützen
- Kann Feldversuche machen

Example: Development and Industrialization of a RF MEMS

Industrial Partner: Reinhardt-Microtech AG, Wangs, CH

- An experienced supplier in thin-film circuits on microwave substrates.
- Good customer relations
- Small R+D resources
- Limited competences in the field of application of their products.

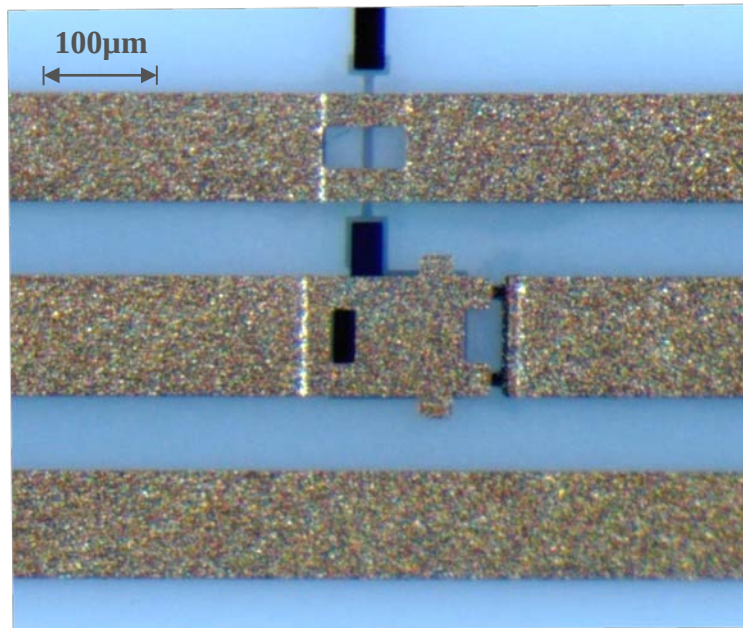


reinhardt
MICROTECH

Development and Industrialization of a RF MEMS

Innovation

- Make micro-electromechanical switches available in order to enable true time delay networks used in electronic scanning antennas.
- The same MEMS fabrication process can be used to realize programmable matching networks or programmable filter networks



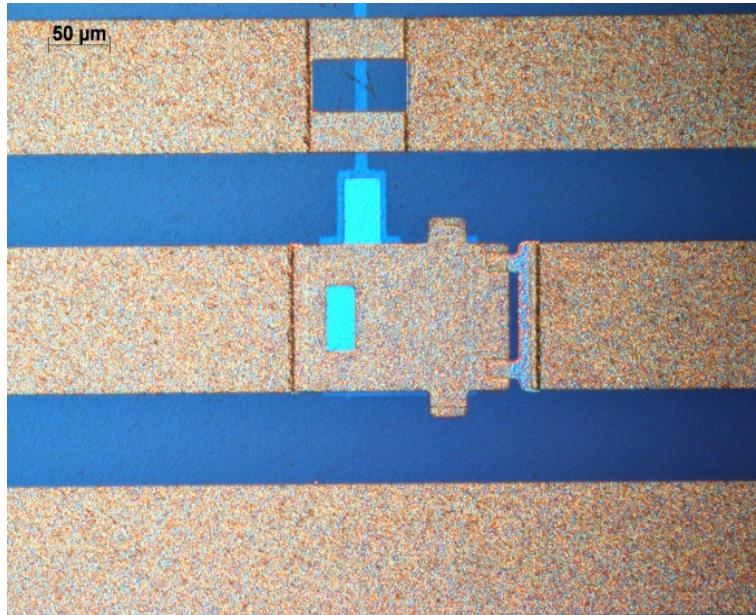
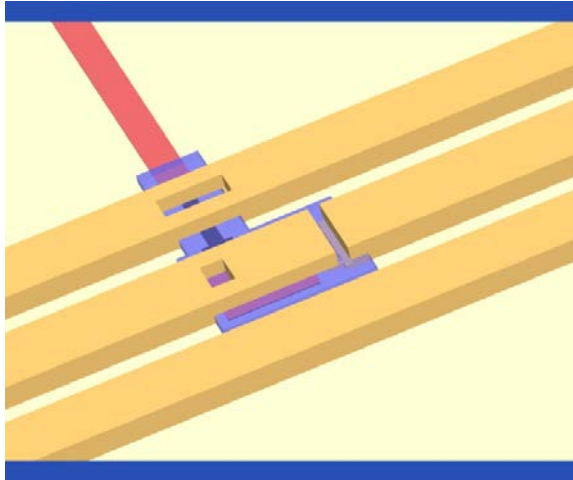
Development and Industrialization of a RF MEMS

Founding

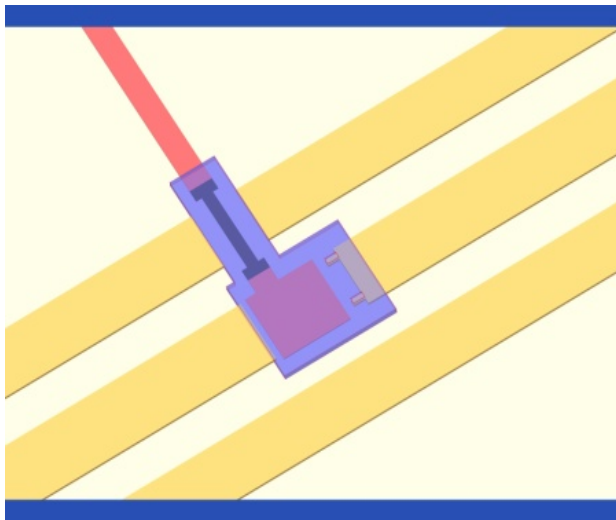
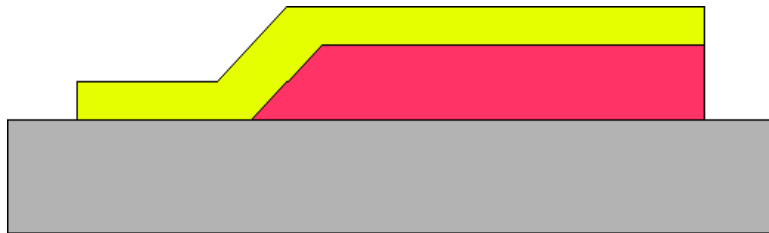
- European Project (EURIMUS) coordinated by THALES
- KTI/CTI Founding 381kCHF

External Partners:

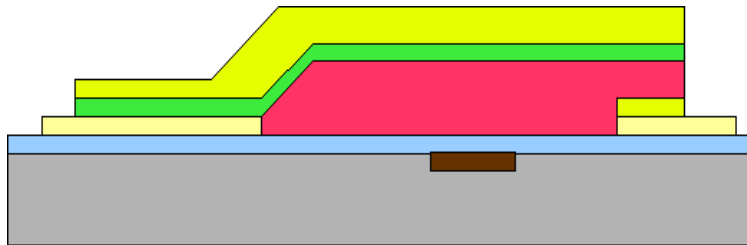
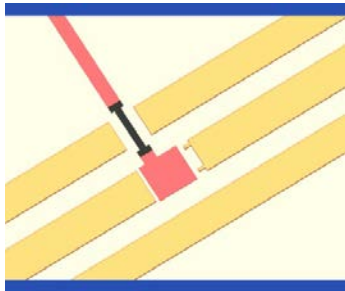
- System integration, THALES
- Independent Expertise's, CNES
- «Field trials», ESA
- First demonstrators in lab, non-compatible with industrial purposes, XLIM
- Redesign, process development and material evaluation, technology transfer, process validation, measurement and analytics, NTB



- Contents
- 1. Switch
 - Process-development and fabrication
- 2. Packaging
- 3. Simulation



- Cantilever
- Sputtering (compressive stress)
- Electrochemical Deposition
 - → No intrinsic stress
- Sacrificial Layer

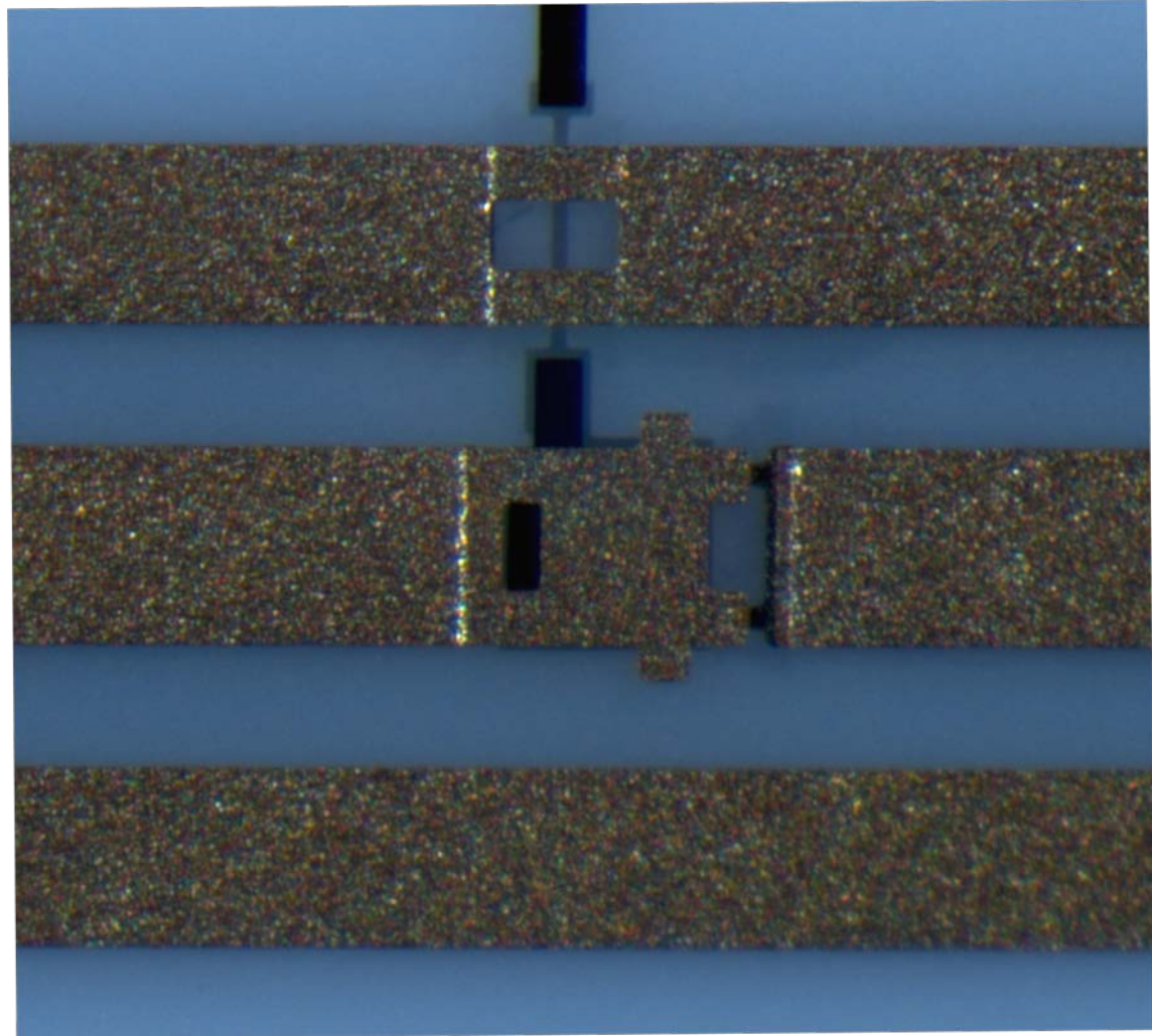


- Actuation pad
- High resistor in series for decoupling from RF
- Only Cr Si

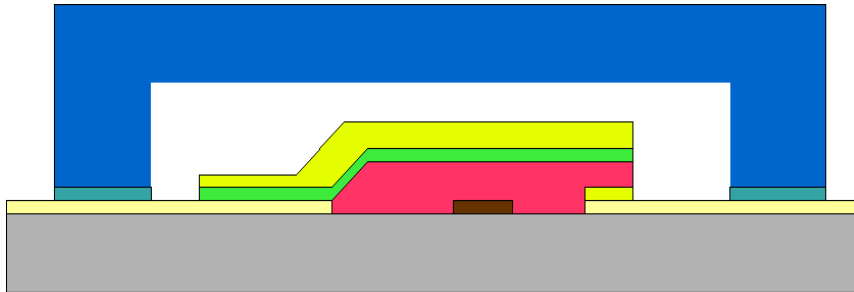
- Dielectric
- SiO_2
- Al_2O_3
- Si_xNi_y

Final Switch as fabricated at RMT

- Jeder Prozessschritt wurde an der NTB neu entwickelt und angepasst und dann bei RMT in der Linie durch Standardpersonal ausgeführt.

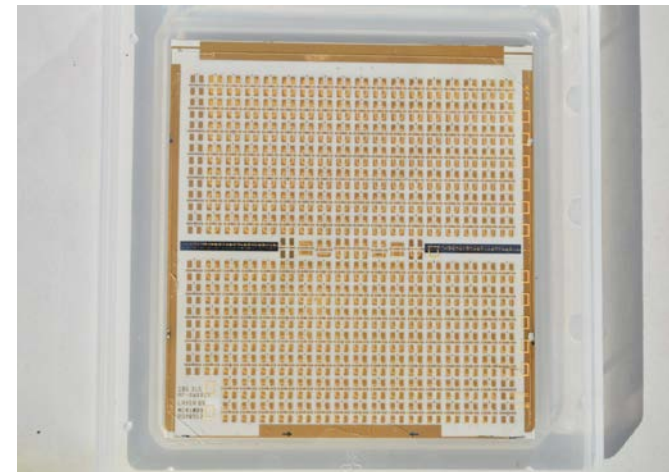
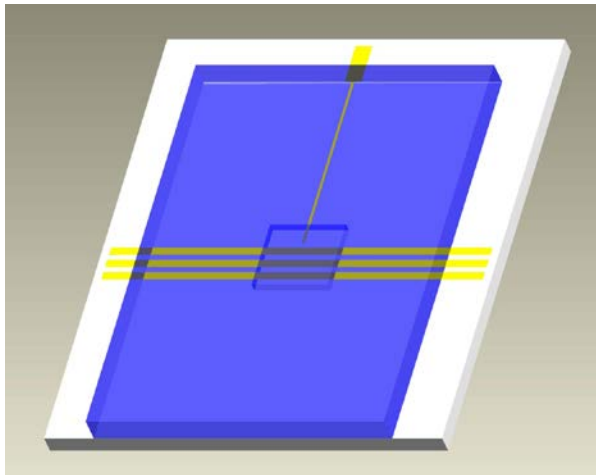
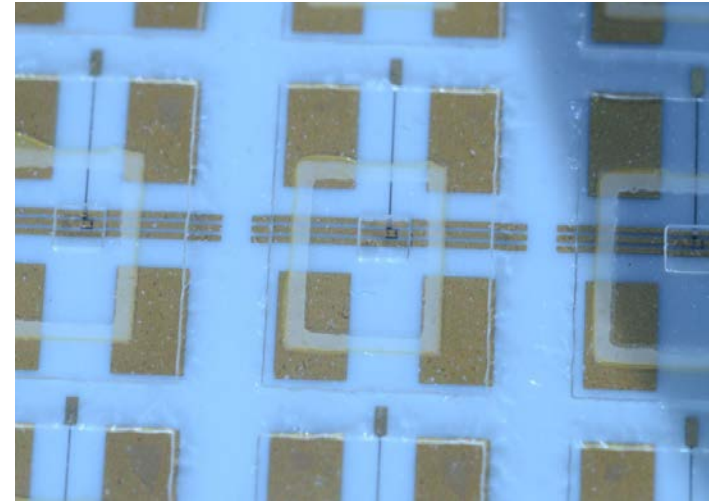


- Issues:
- Gas tight
- Dielectric
- Bond Temp $< 300^{\circ}\text{C}$



- Glass cap

- Glass etching
- Screenprinting of the epoxy
- 2 step dicing



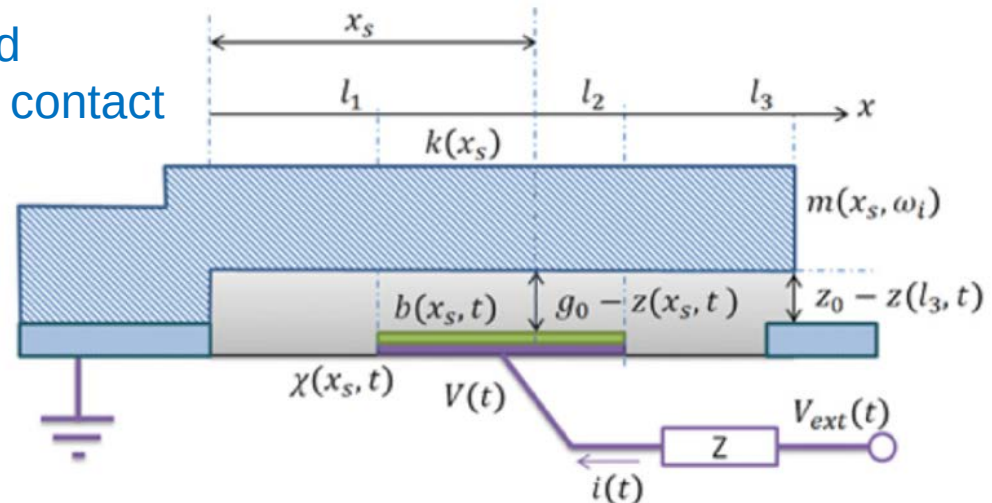
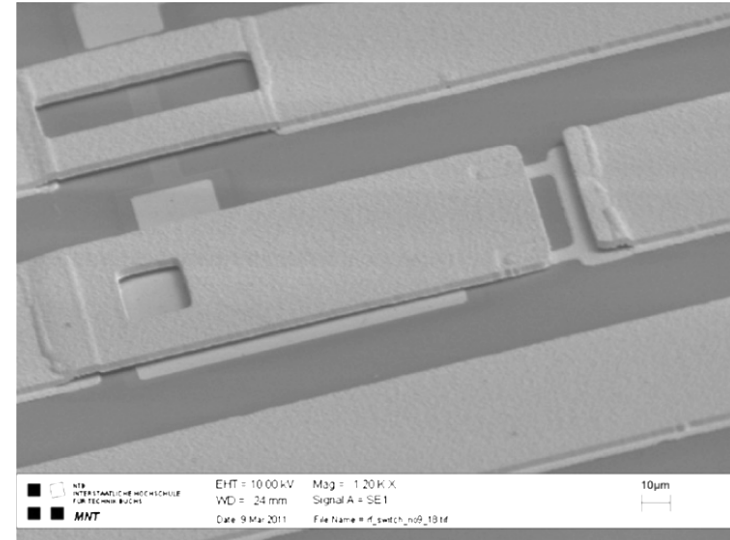
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Modelling and Design

Which actuation voltage is required for a given RF isolation and contact pairing?

What are the influences of disturbances and process tolerances?

What are suitable dimensions and materials in order to increase the contact life-time?



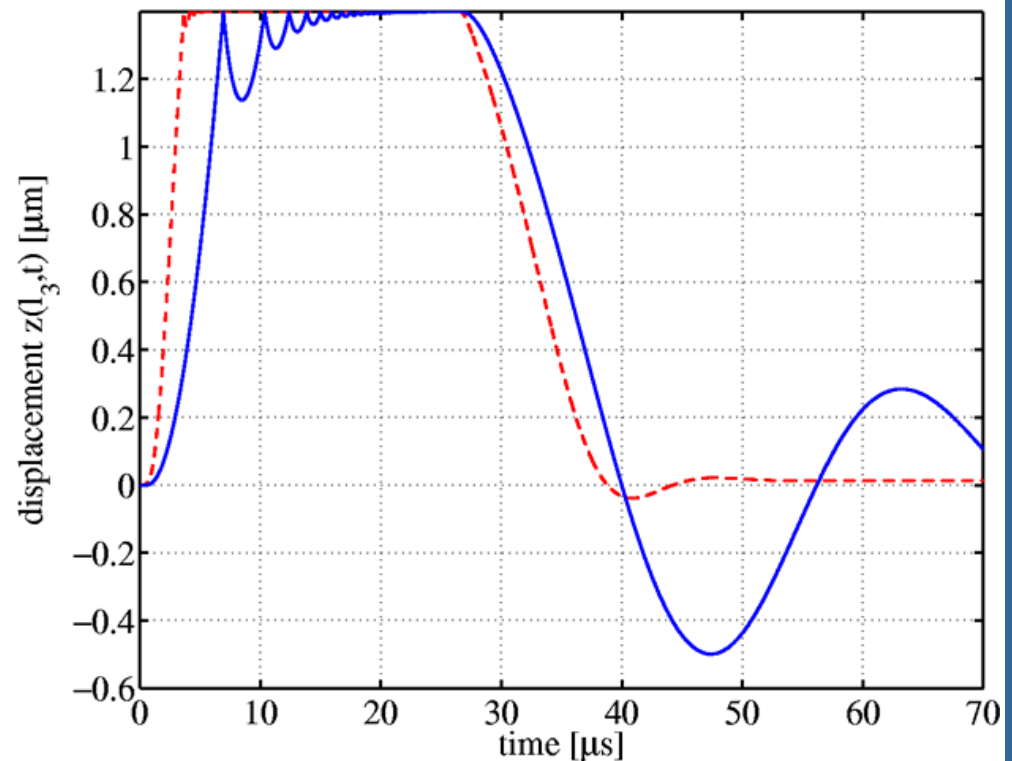
Tuning by the choice of the cantilever material density

What is the influence of the cantilever material density
 $\rho = (2700 \text{ kg/dm}^3, 19300 \text{ kg/dm}^3)$ on the switching dynamics?

Since gold and aluminium have nearly the same plain-strain elasticity modulus, the static contact force is approximately the same.

Faster switch on and switch off is achieved by using aluminium instead of gold.

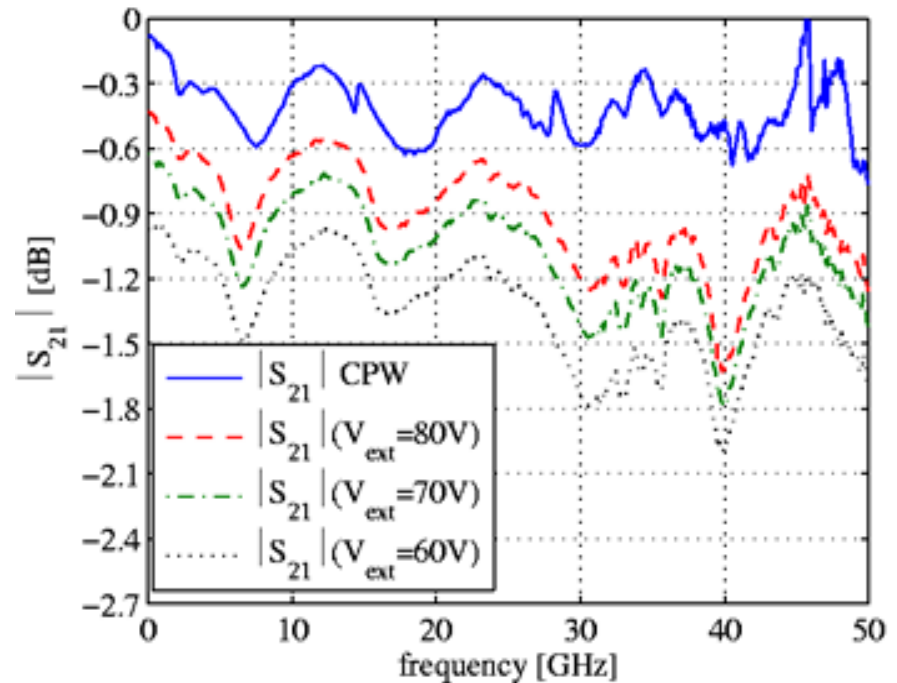
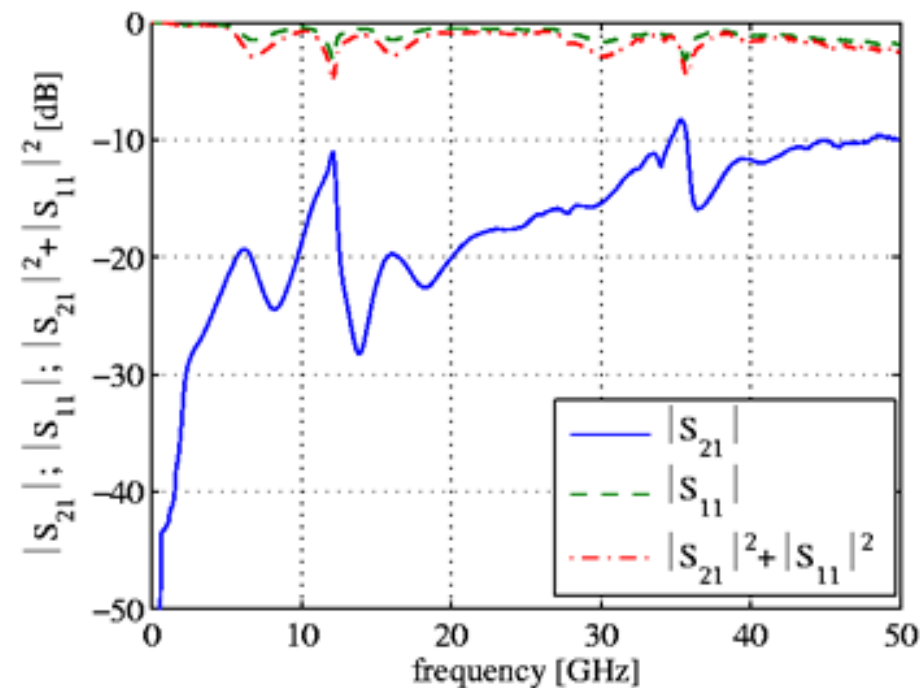
In addition bouncing is reduced due to the lower resonant mass.



Development and Industrialization of RF MEMS

Characterization

- The fabricated switch show excellent isolation in the off-state. The insertion loss of the switch depends on the contact force.



**resonances stemming from the feed line length*

Zusammenfassung

- Forschungsergebnisse in die Industrie übertragen bedingt eine gewisse Anstrengung → Projekt
- Es bedeutet meist auch Anpassung der Prozesse.
- Externe (Hochschul-) Partner können dabei helfen (Ressourcen, zusätzliches Knowhow).

Der Transfer gelingt!