Flexible magnetosensitive interfaces and devices based on polymeric composites

Eduardo Sergio Oliveros Mata

PhD Report

15.11.22

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Track

Integration of flexible magnetic field sensors for touch-less interfaces and soft actuators
Helmholtz-Zentrum Dresden-Rossendorf
October 2019 – Ongoing Dresden, Germany

Micromotors propelled by ultrasound
Centro de Nanociencias y Nanotecnologia
2017 Ensenada, Mexico

Density Asymmetry Driven Propulsion of Ultrasound-Powered Janus Micromotors
M Valdez-Garduño, M Leal-Estrada, **ES Oliveros-Mata**, ...
Advanced Functional Materials 30 (50), 2004043, 2020

Impedimetric nanosensor for microfluidic cytometry
Max Bergman Zentrum
Nov 2018 – Sep 2019 Dresden, Germany

Nanocytometer for smart analysis of peripheral blood and acute myeloid leukemia: a pilot study J Schütt, DI Sandoval Bojorquez, E Avitabile, **ES Oliveros Mata**, ...
Nano Letters 20 (9), 6572-6581, 2020

Self-healable printed magnetic field sensors using alternating magnetic fields R Xu, GS Cañón Bermudez, O Pylypovskyi, **ES Oliveros Mata**...
Nature Communications 13, 6587, 2022

Printable and Stretchable Giant Magnetoresistive Sensors for Highly Compliant and Skin-Conformal Electronics
M Ha, GS Cañón Bermudez, T Kosub, I Mönch, Y Zabila, **ES Oliveros Mata**...
Advanced Materials 33 (12), 2005521, 2021

Flexible magnetoreceptor with tunable intrinsic logic for on-skin touchless human-machine interfaces P Makushko, **ES Oliveros Mata**, GS Cañón Bermúdez, M Hassan, ...
Advanced Functional Materials 31 (25), 2101089, 2021

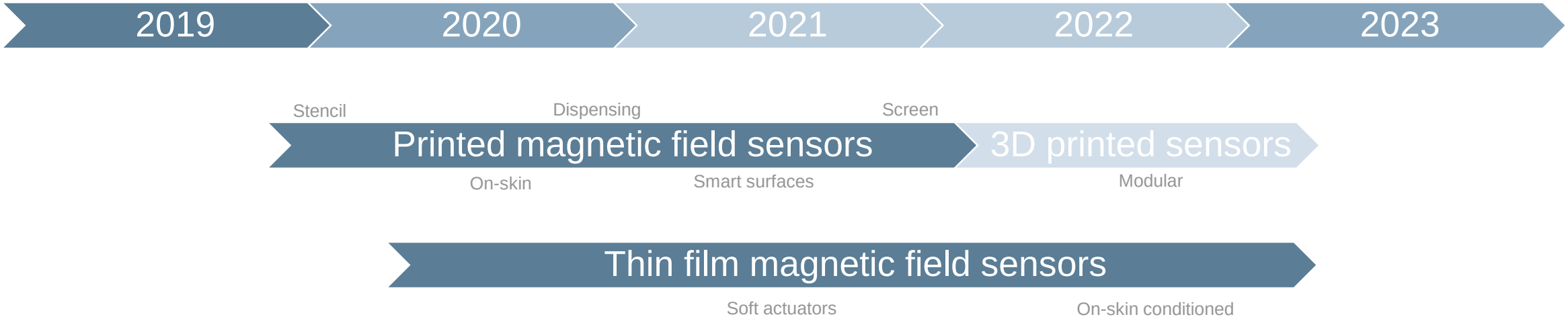
Reconfigurable Magnetic Origami Actuators with On-Board Sensing for Guided Assembly M Ha, GS Cañón Bermúdez, JAC Liu, **ES Oliveros Mata**, BA Evans, ...
Advanced Materials 33 (25), 2008751, 2021

Domain-Wall Damping in Ultrathin Nanostripes with Dzyaloshinskii-Moriya Interaction OM Volkov, F Kronast, C Abert, **ES Oliveros Mata**, T Kosub, P Makushko, ...
Physical Review Applied 15 (3), 034038, 2021

Printable anisotropic magnetoresistance sensors for highly compliant electronics **ES Oliveros Mata**, GS Cañón Bermúdez, M Ha, T Kosub, Y Zabila, ...
Applied Physics A 127 (4), 1-6, 2021
(In Memoriam to S. Bauer)

Dispenser Printed Bismuth-Based Magnetic Field Sensors with Non-Saturating Large Magnetoresistance for Touchless Interactive Surfaces **ES Oliveros-Mata**, C Voigt, GS Cañón Bermúdez, Y Zabila, ...
Advanced Materials Technologies, 2200227, 2022

Timeline overview for PhD



Flexible magnetosensitive interfaces and devices based on polymeric composites

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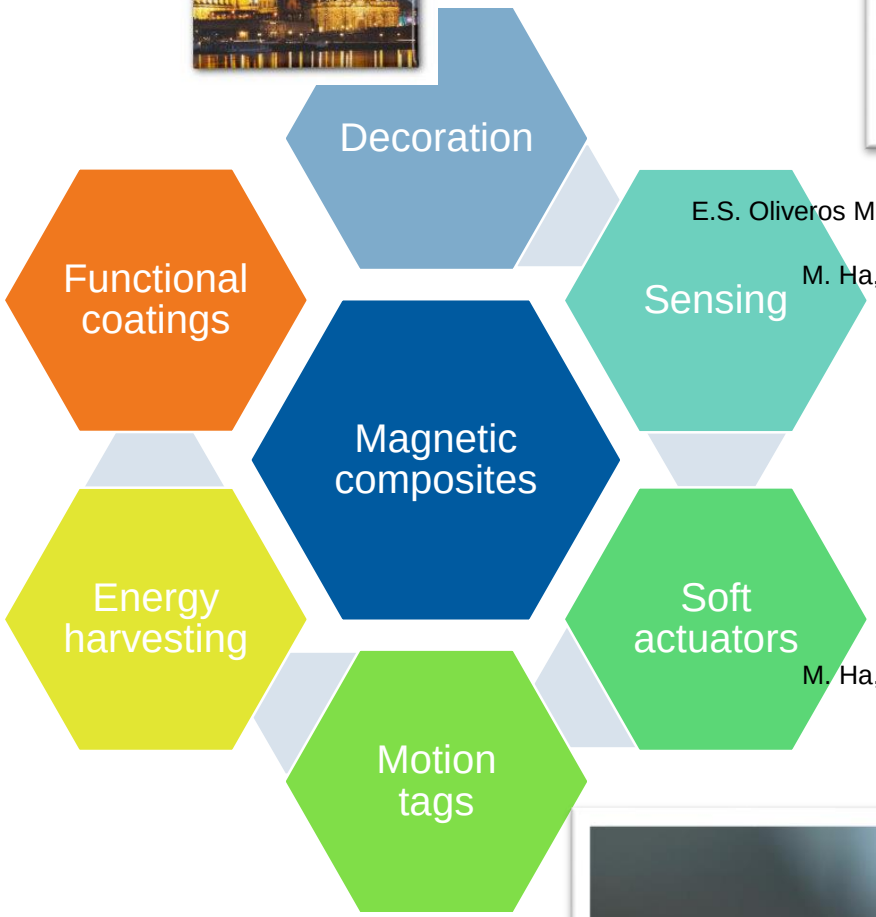
Magnetic polymeric composites

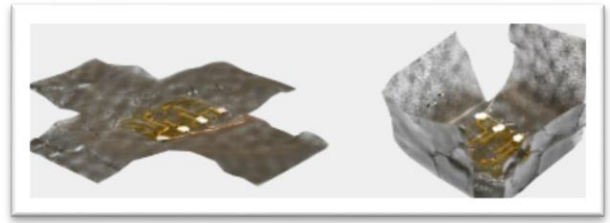
www.zazzle.de/dresden+magnete

Yang, X, et al. *Sci. Robot*, ***5***(48), eabc8191. (2020)

Zhou, Y., et al. *Nat. Mater*. (2021)



E.S. Oliveros Mata, C. Voigt**,** et al. *Adv. Mater. Technol* **7**(10)**,** 2200227 (2022)
E.S. Oliveros Mata, et al. *Appl. Phys. A* **127**(4)**,** 280 (2021)
M. Ha, E.S. Oliveros Mata**,** et al. *Adv. Mater.* **33**(12)**,** 2005521 (2021)
R Xu, ES Oliveros Mata, et al. *Nat. Comm*. **13**, 6587 (2022)



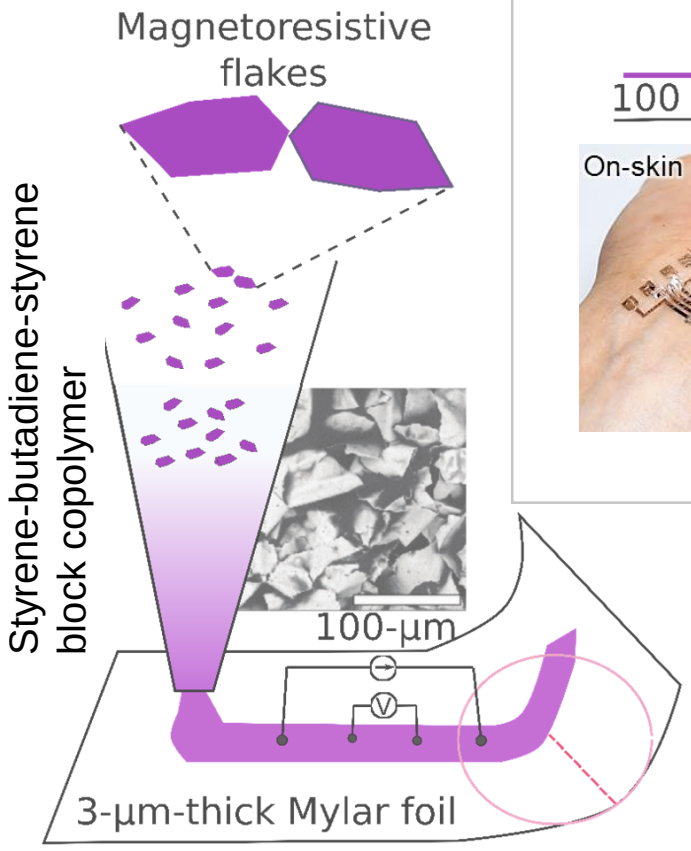
M. Ha, E.S. Oliveros Mata**,** et al. *Adv. Mater.* **33**(25)**,** 2008751 (2021)

Almansouri, A. S., et al. *Adv. Mater.Tech.* ***4***(10), 1900493. (2019).

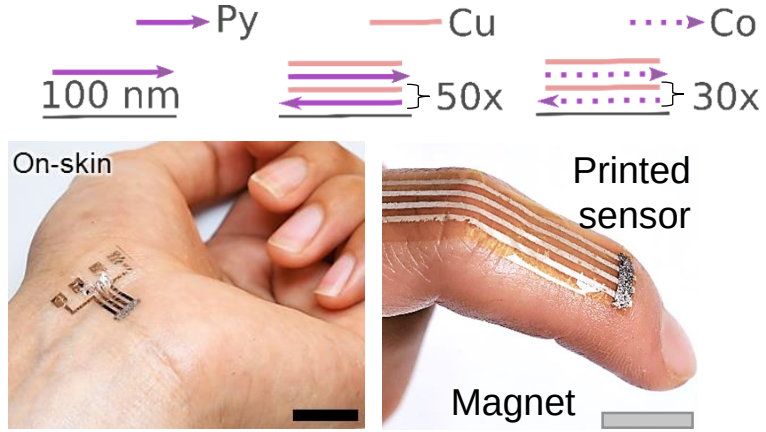
Magnetic composites have a wide range of applications

Magnetic composites for printable sensors

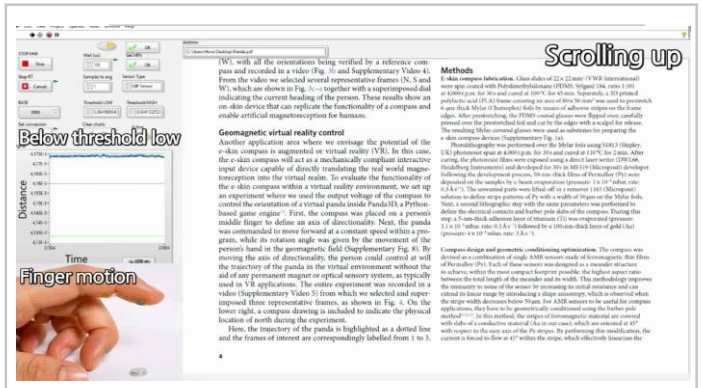
Fabrication



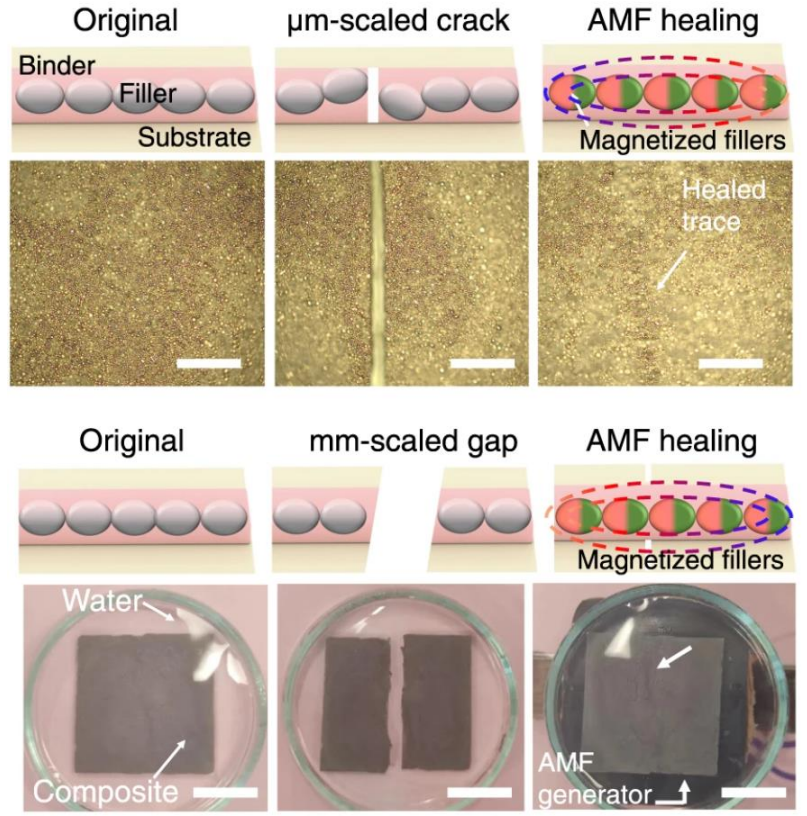
Printed magnetoresistors



Interactive on-skin electronics



Self healing sensors



R Xu, …, **ES Oliveros Mata**, et al. *Nat. Comm.* **13**, 6587 (2022)

Oliveros Mata, E.S., et al. *Appl. Pys. A* **127**(4)**,** 280 (2021)

M. Ha, **Oliveros Mata,** et al. *Adv. Mater.* **33**(12)**,** 2005521 (2021)

Magnetoresistive composites were used to obtain printed magnetic field sensors

Thanks to M Ha, GS Cañón Bermúdez, R Xu, T Kosub

NiFe (permalloy) containing powders

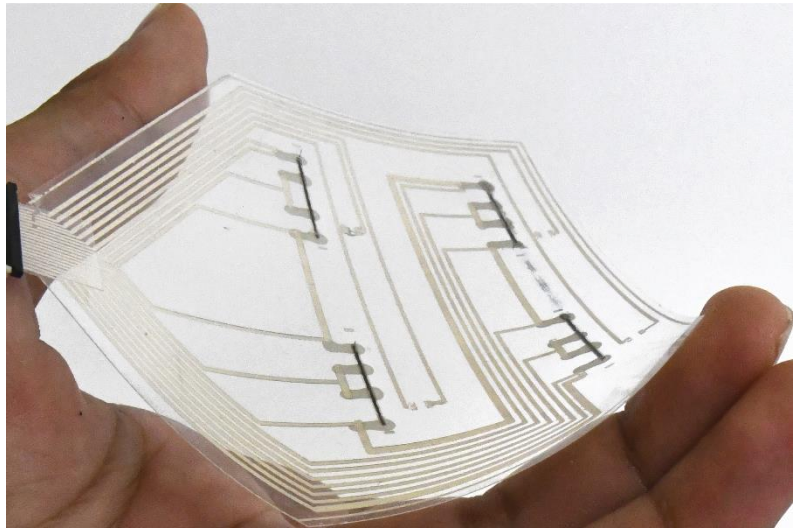
Health and safety information (SDS)

	NiFe	Bi
Signal Word	Danger	Warning
Hazard statements	H228 Flammable solid H317 May cause an allergic skin reaction H351 Suspected of causing cancer H372 Causes damage to organs through prolonged or repeated exposure	H228 Flammable solid
Water hazard class	2 Obviously hazardous to water	Nwg Non-hazardous to water
Pictograms		

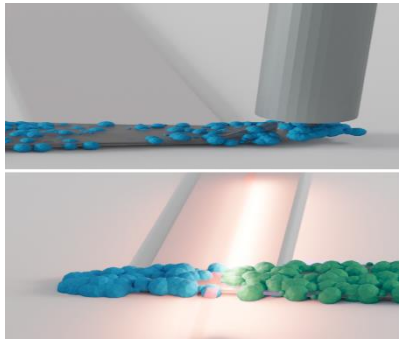
https://www.americanelements.com/iron-nickel-powder

https://www.americanelements.com/bismuth-powder-7440-69-9

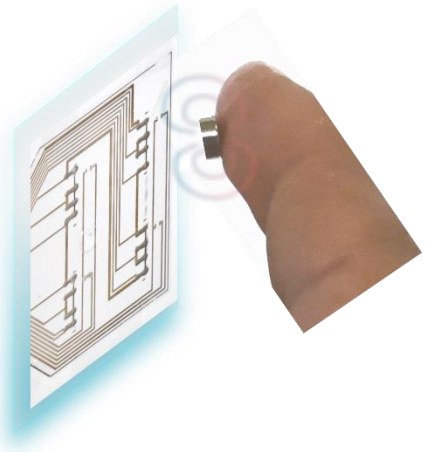
Non-saturating large magnetoresistance in printed sensors



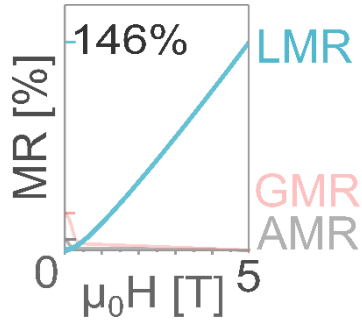
Laser sintering



Interactive surfaces



Large magnetoresistance effect



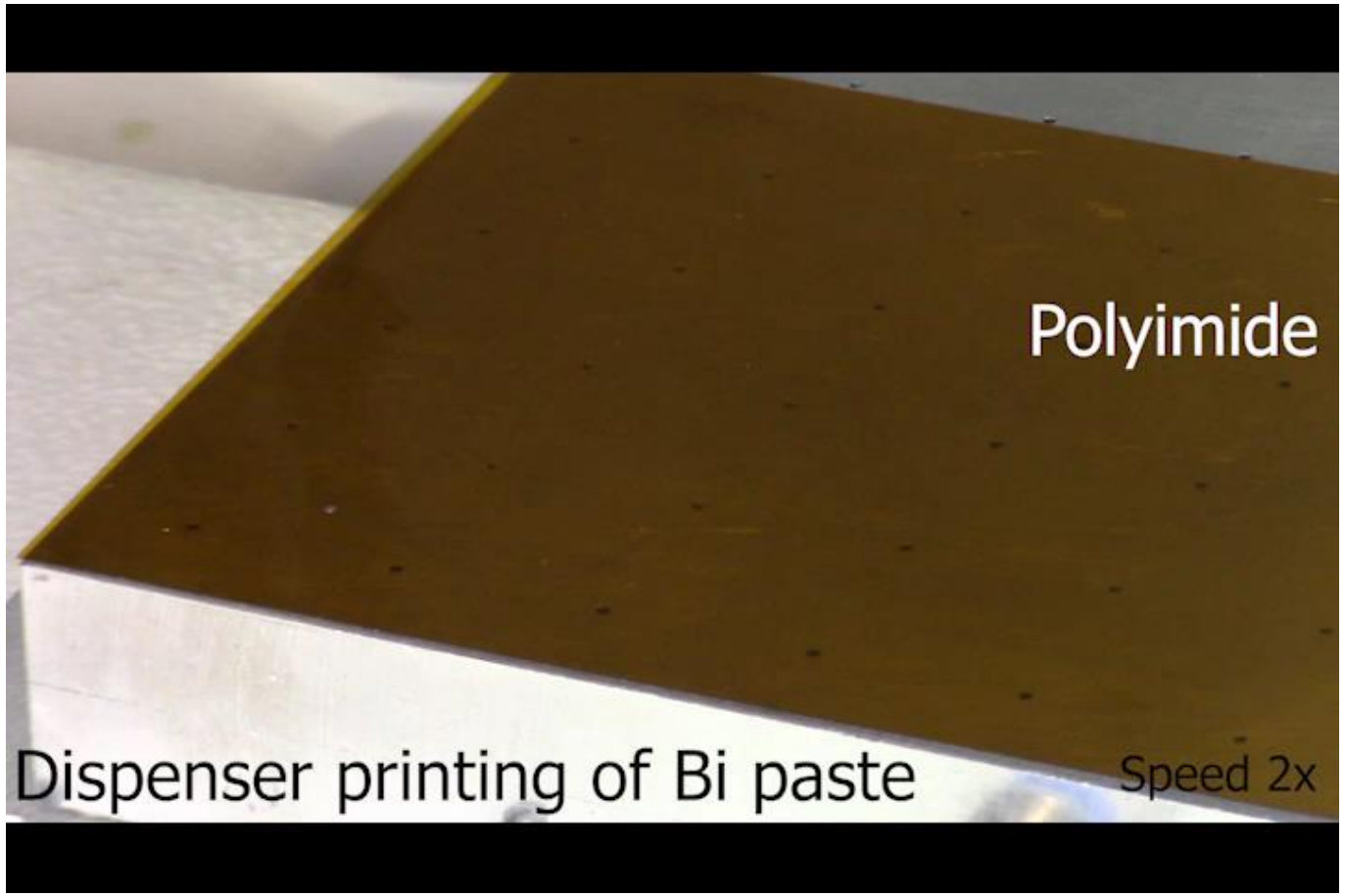
Everyting becomes an interface

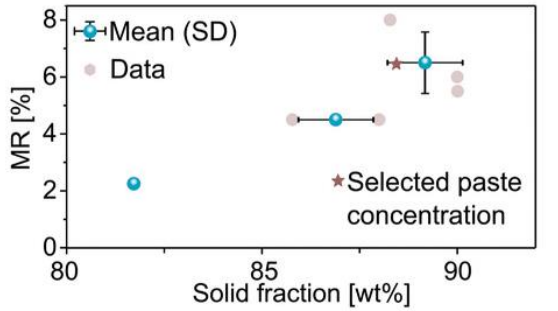
Oliveros-Mata, E.S. *Adv. Mater. Technol.* 2000227 (2022)

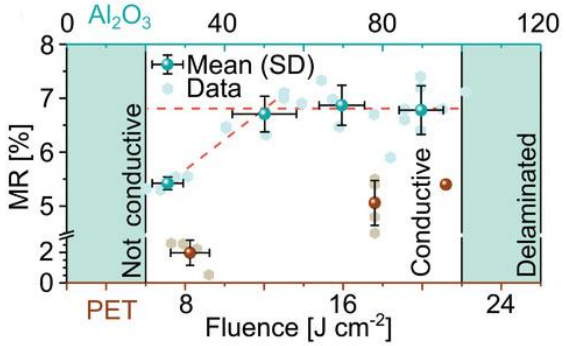
Fraunhofer IKTS · Technische Universität Dresden · Dresden concept · HZDR

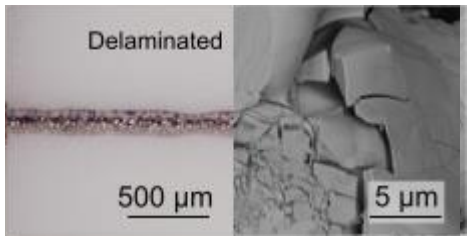
Fabrication

LIMO900 Line Laser
Treatment in air
30 × 0.1 mm^2 laser beam
λ = 980 nm 500 mT





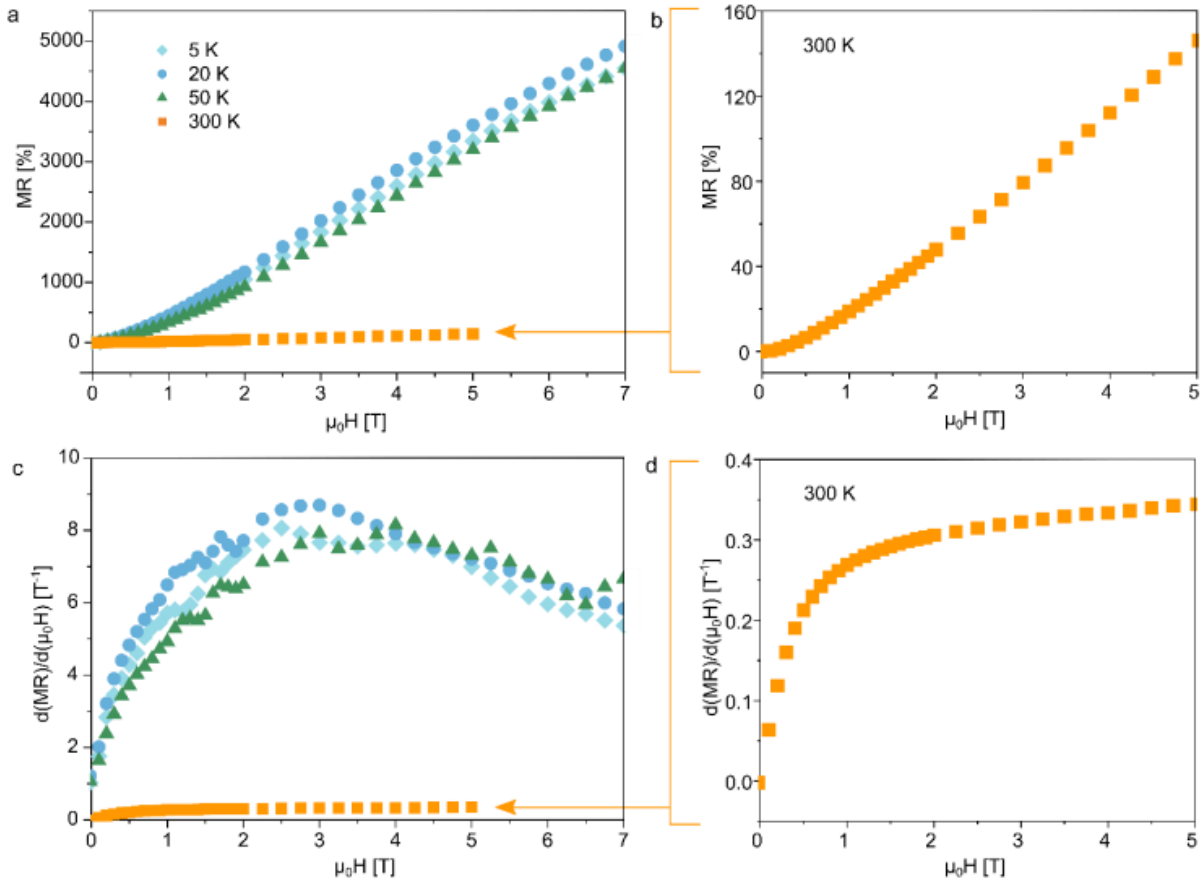




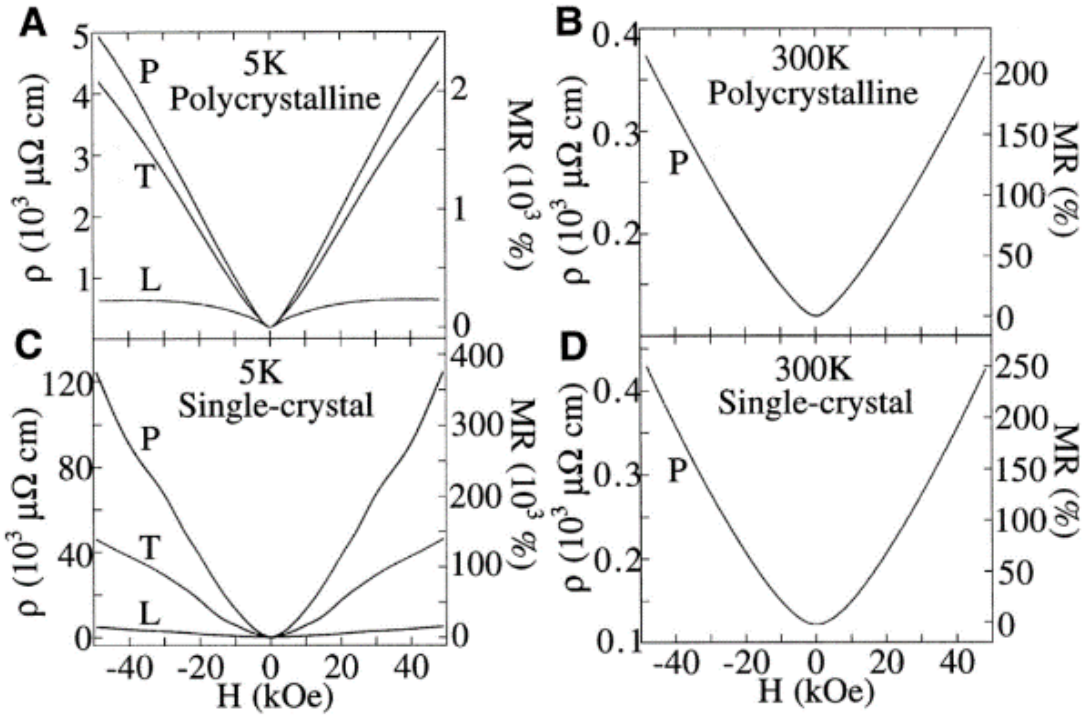
Oliveros-Mata, E.S. *Adv. Mater. Technol.* 2000227 (2022)

Thanks to C Voigt, M Vinnichenko

Non-saturating large magnetoresistance



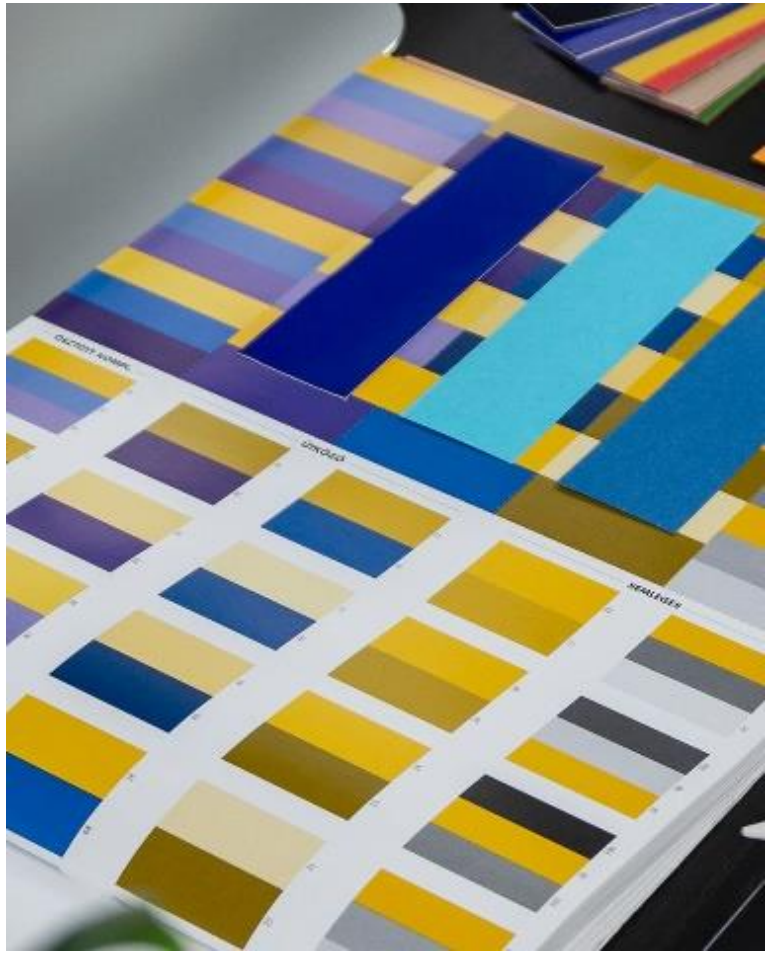
Oliveros-Mata, E.S. *Adv. Mater. Technol.* 2000227 (2022)



Large magnetoresistance of electrodeposited single-crystal bismuth thin films. *Science* **284**. 1335 (1999)

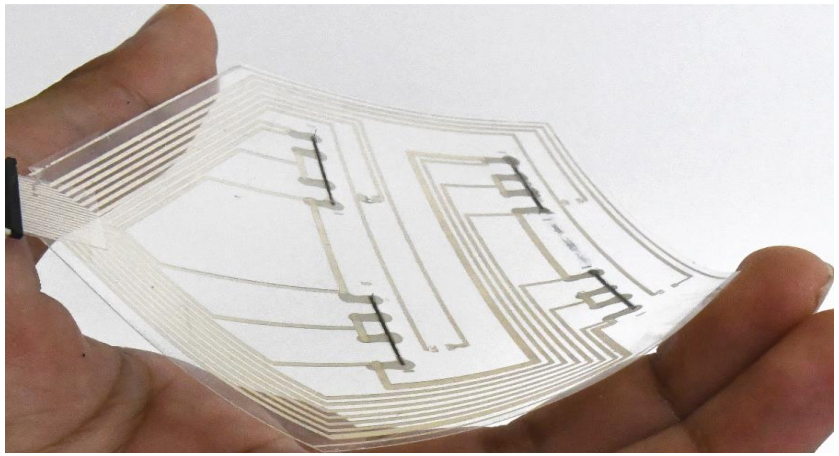
Thanks to S Zhou

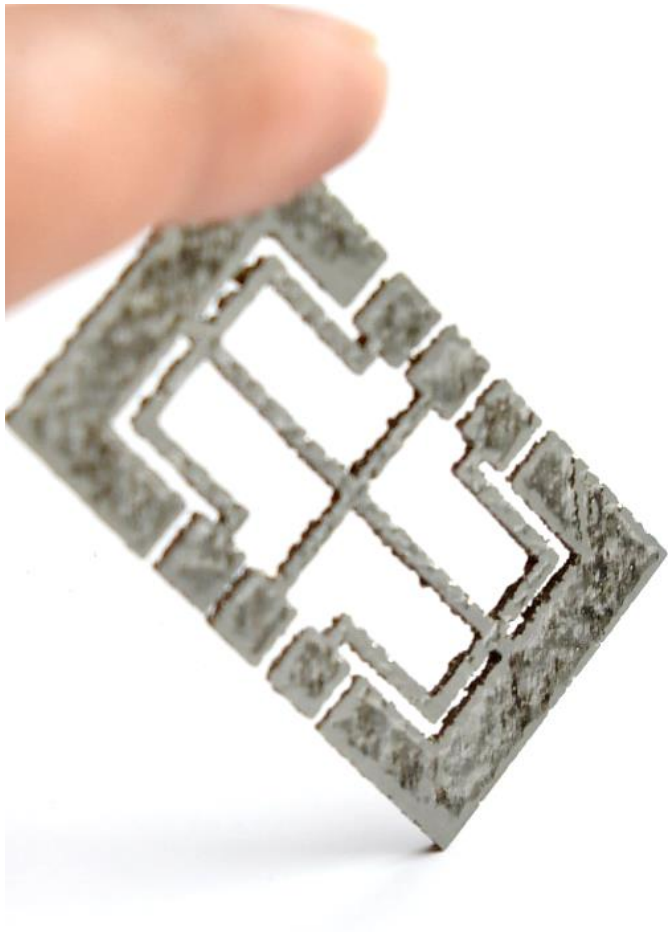
From 2D printing to 3D printing



https://unsplash.com/photos/LPWl2pEVGKc

https://shop.solidpro.de/de/hp-jet-fusion-580-color.html

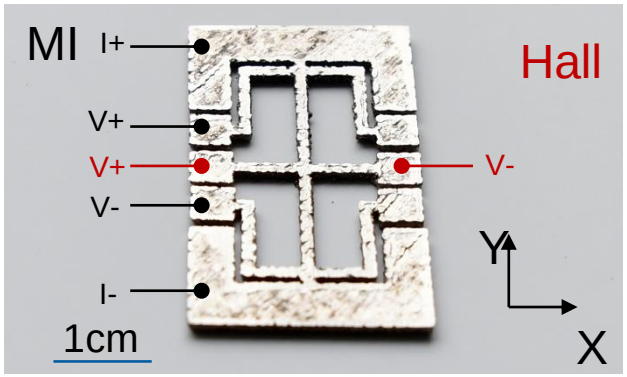


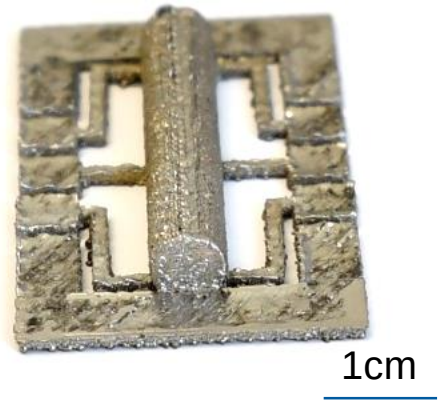


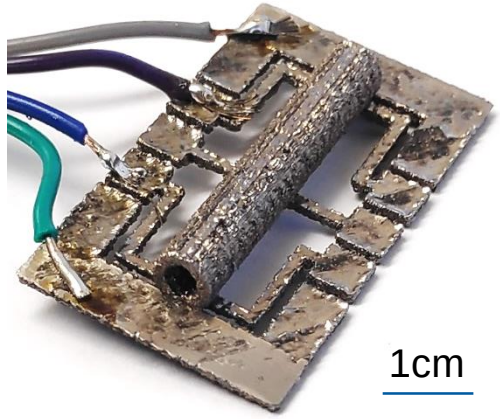
Thanks to A Martin Villardel, L Stepien, F Schröder, C Leyens

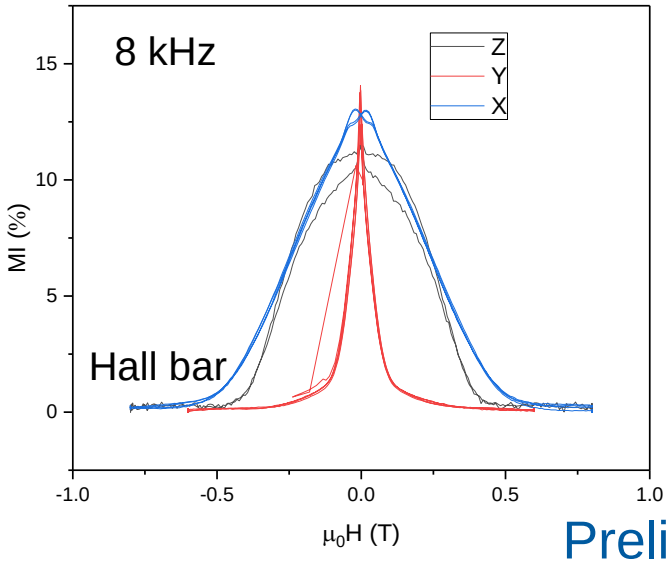
3D printed magnetic field sensors

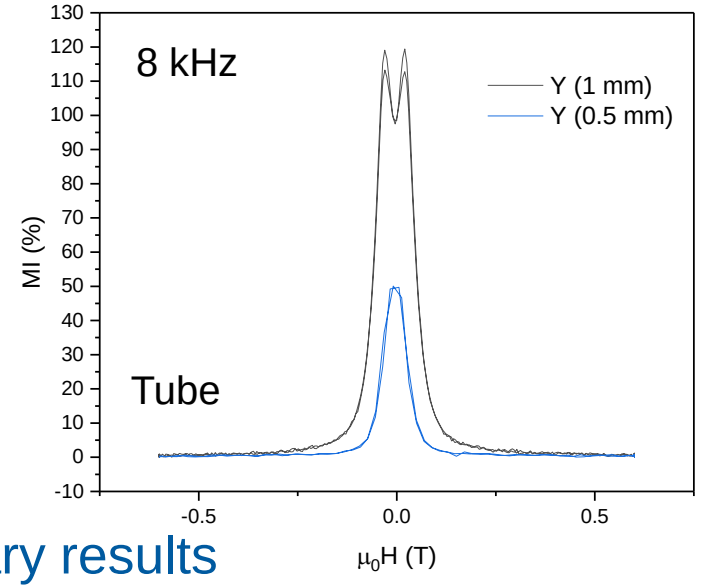
Powder-bed laser-fusion

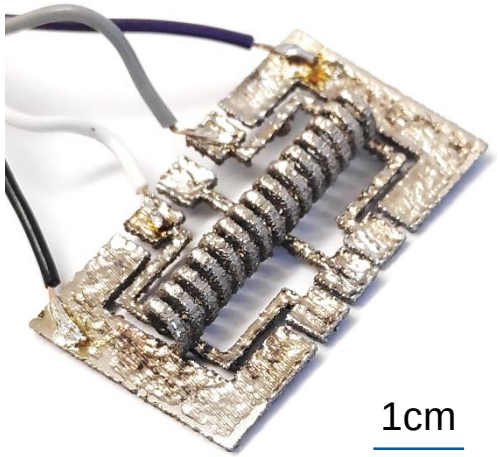








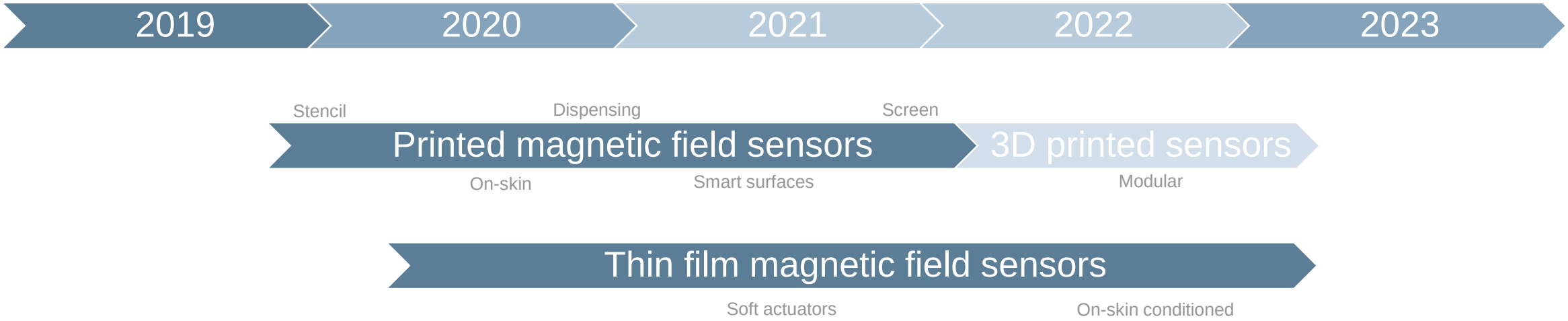




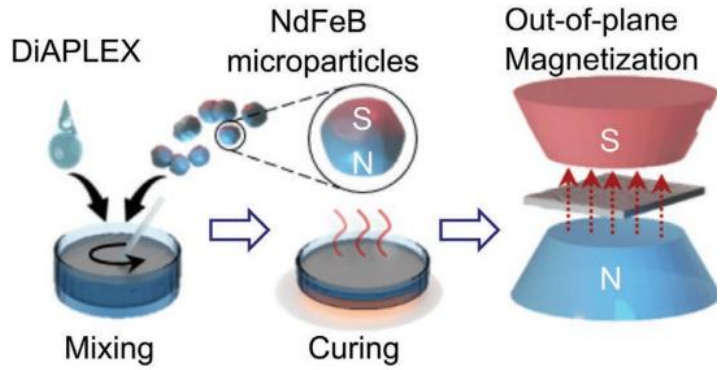
Preliminary results

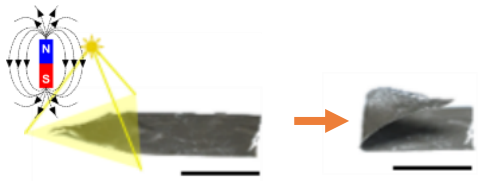
Thanks to A Martin Villardel, L Stepien, F Schröder, C Leyens

Timeline overview for PhD

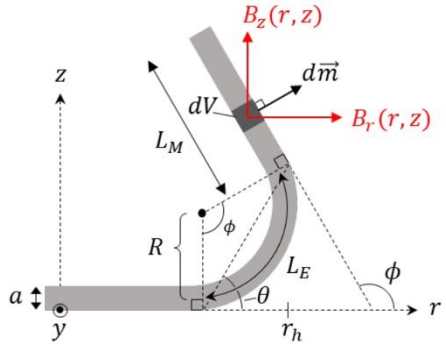


Laminated magnetic field sensors in magnetic origami platform

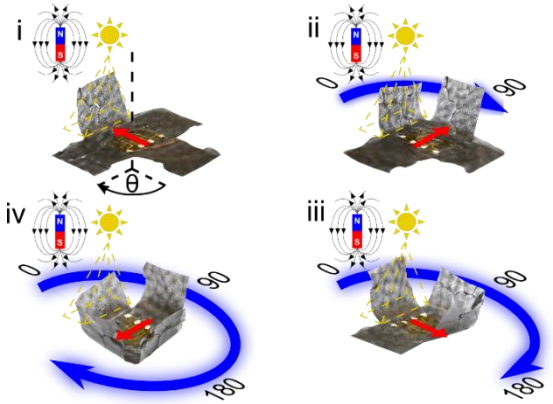




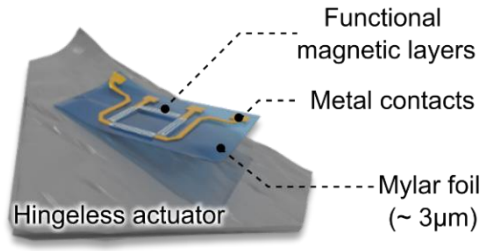
Hingeless origami actuators



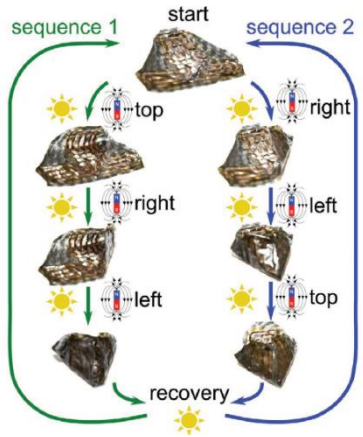
Orientation during assembly



Magnetization state



Folding monitoring

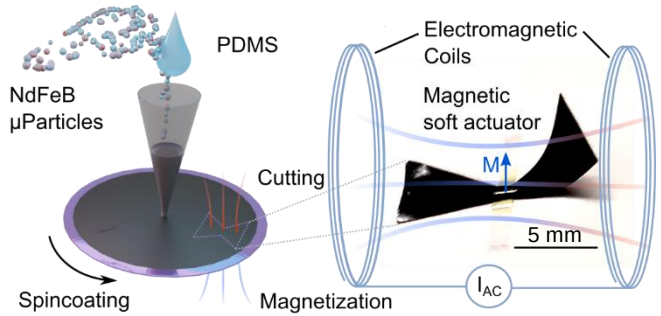


Ha M., **Oliveros Mata E.S.** *Adv. Mater.* **33**(25)**,** 2008751 (2021)

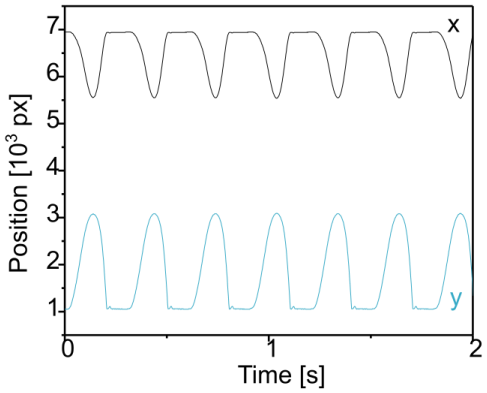
Ultrathin sensors allowed to asses the major processes occurring during folding of magnetic films

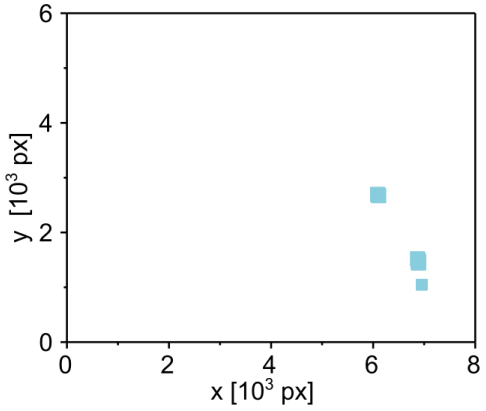
Thanks to A Martin Vilardell, L Stepien, F Schröder, C Leyens

Non linear behaviour of magnetic soft actuators



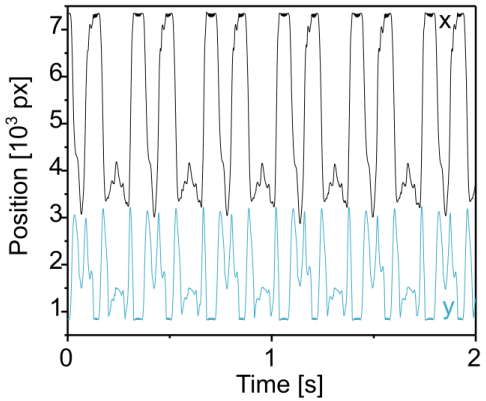
Regular

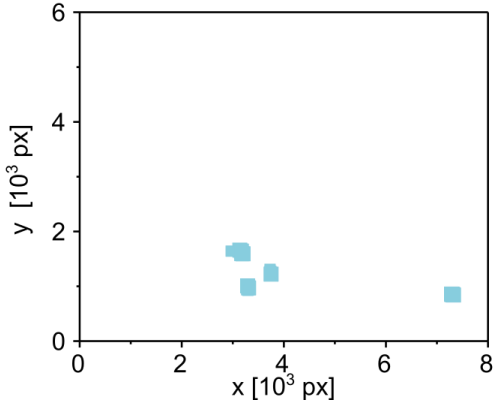




10 Hz (1 mT)

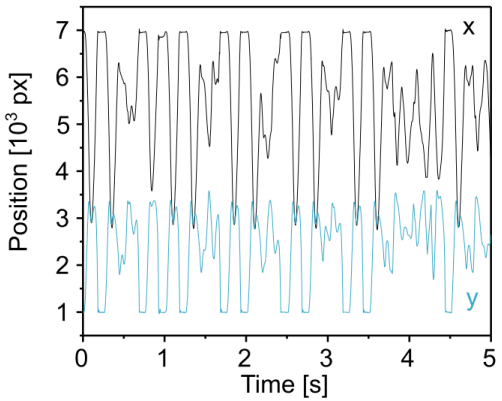
Regular complex

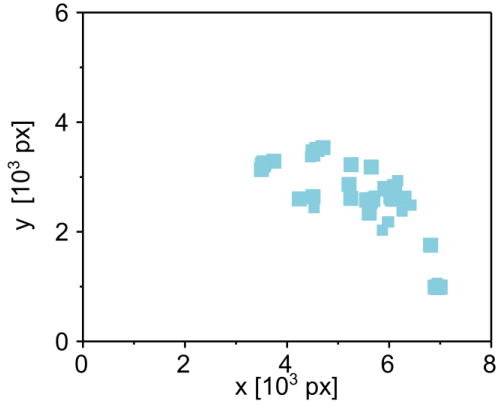




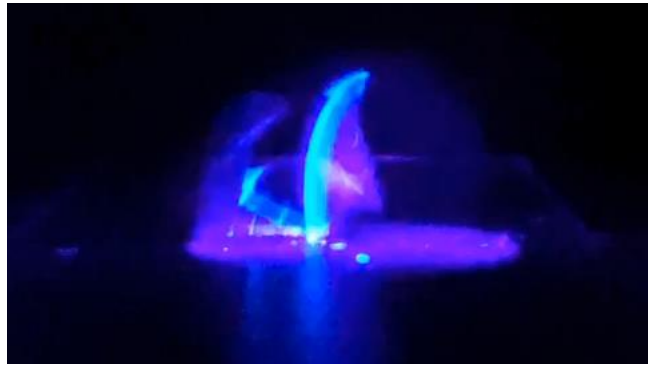
12 Hz (4 mT)

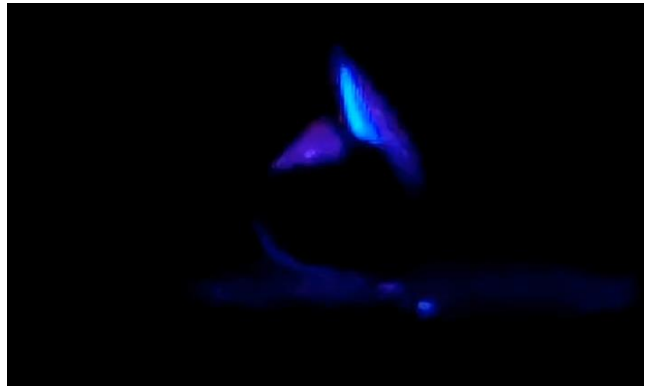
Chaotic





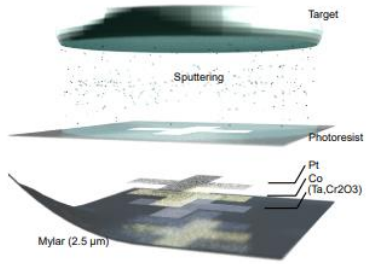
14 Hz (3 mT)

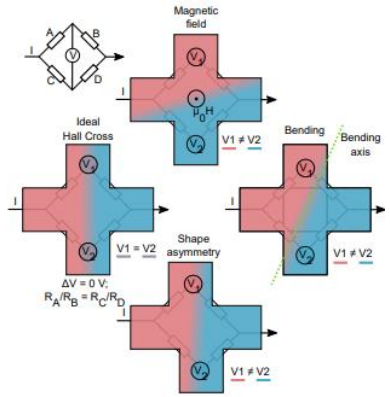


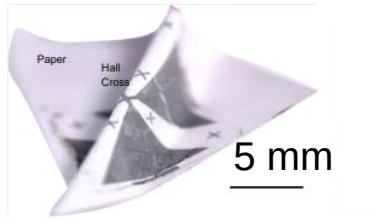


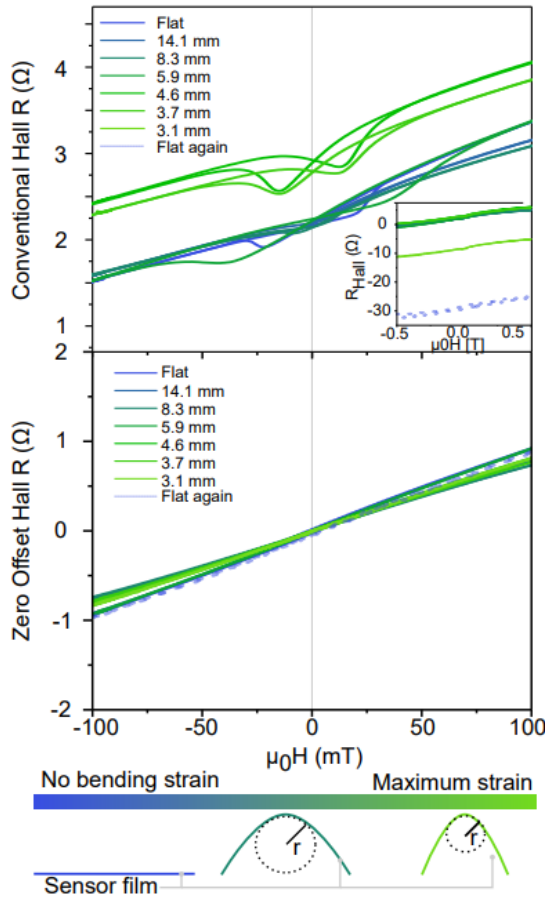
Thanks to O Pylypovskyi, Y Zabila

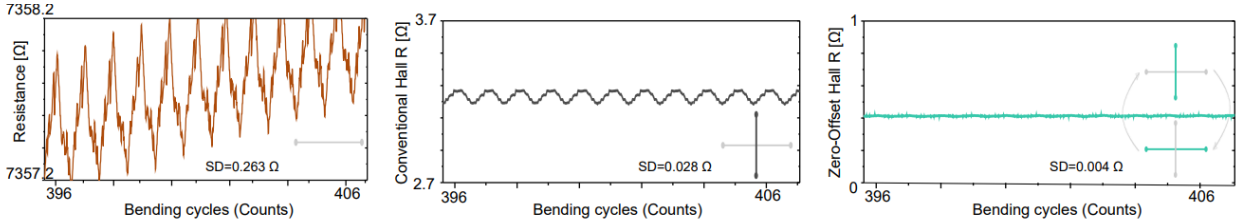
Removing strain contributions from Hall effect sensors

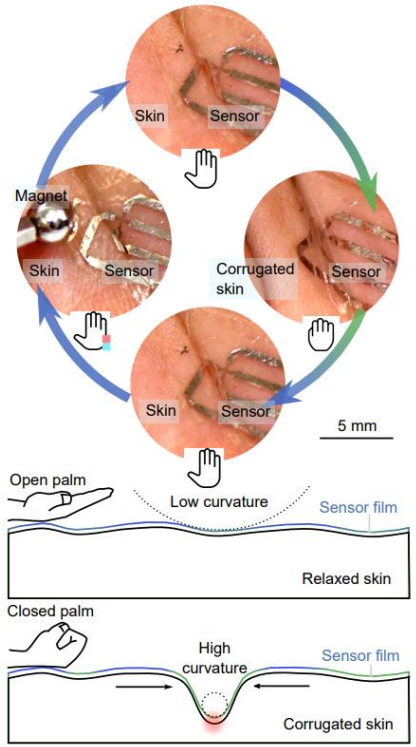


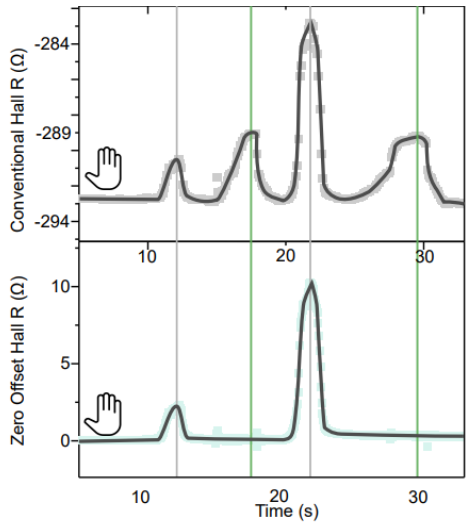












Magnetic field + Strain

Magnetic field

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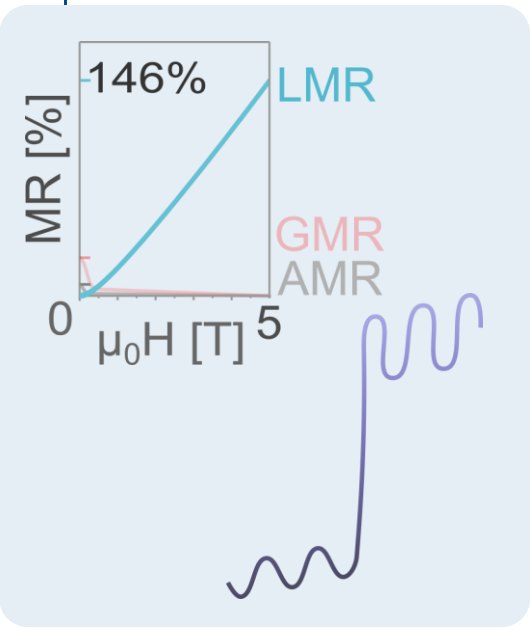
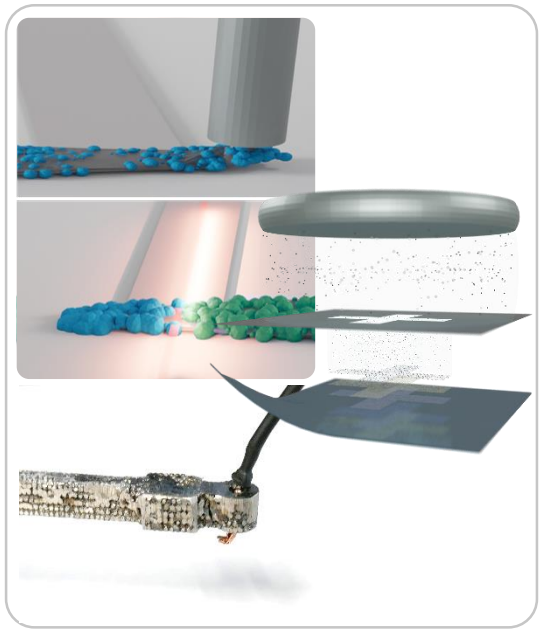
Research overview

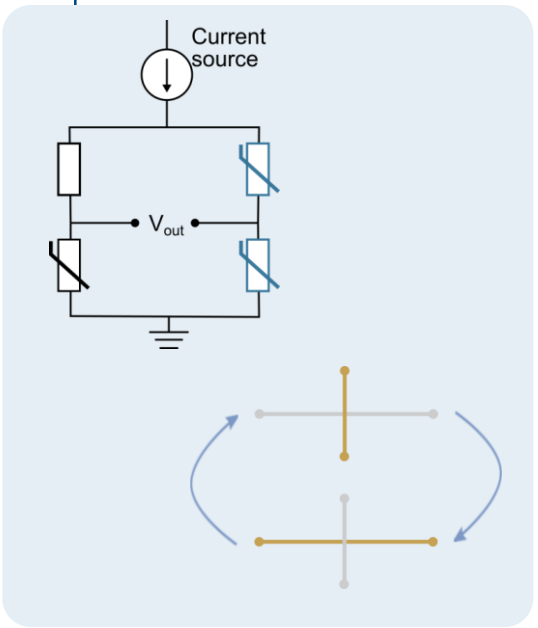
Sensing



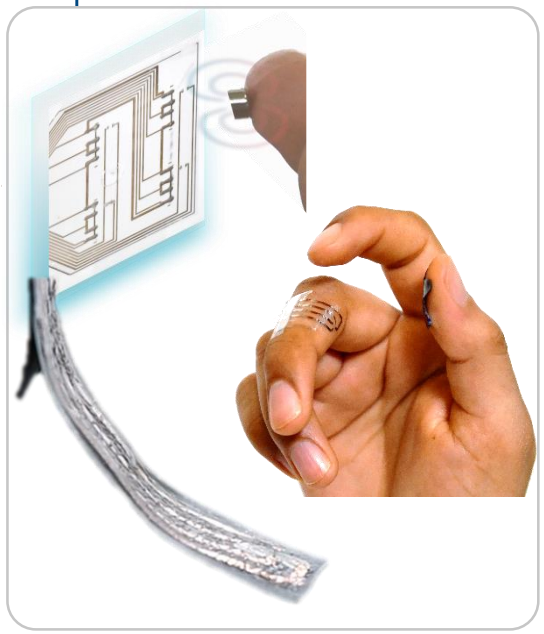
Fabrication



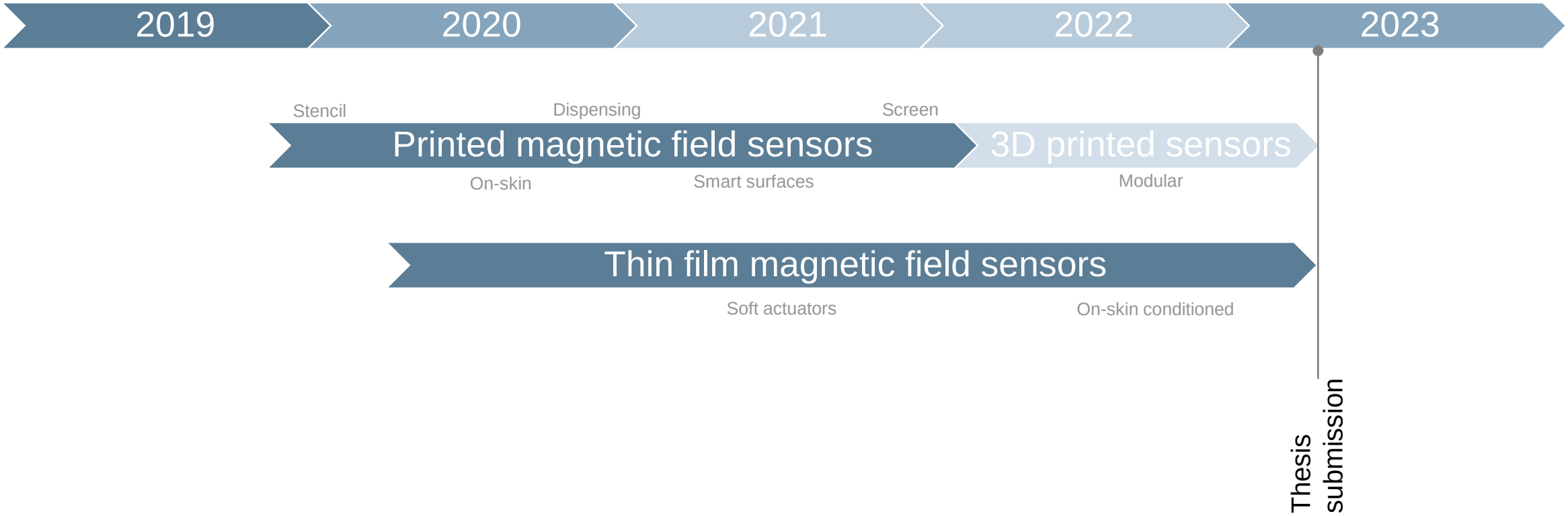
Measuring techniques



Applications



Timeline overview for PhD



HELMHOLTZ ZENTRUM
DRESDEN ROSSENDORF

Thanks for your attention!

Eduardo Sergio Oliveros Mata

PhD Report
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DRESDEN concept