Tohoku University Research Program "Frontier Research in Duo" (FRiD)

Multi-Sensory Flexible Skin

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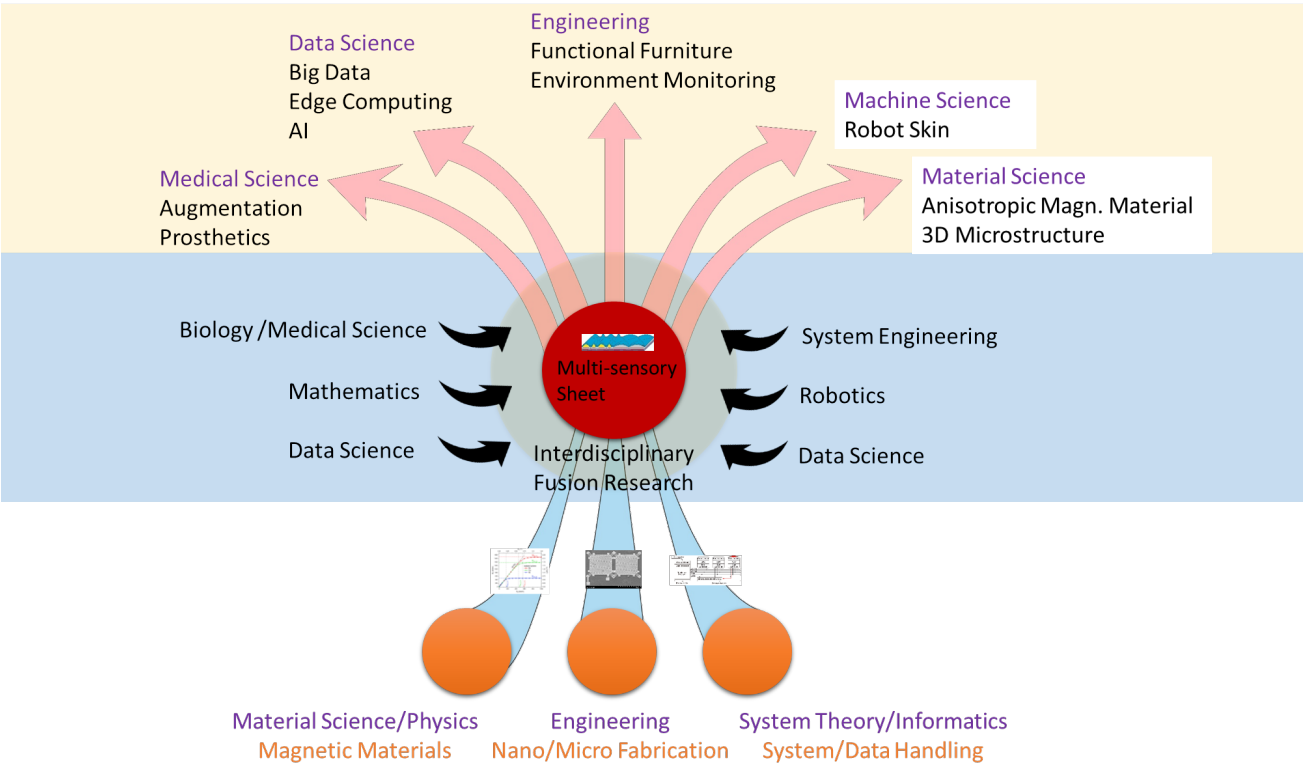
Project Summary

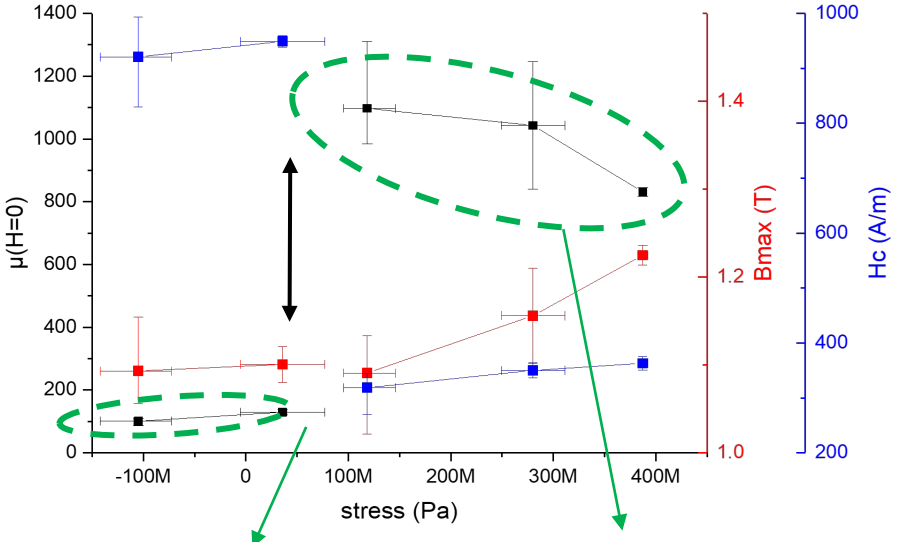
We strife to combine Material Science, Micro-/Nano Sensor Technology, Sensor Network System, Integration of Materials, and Robotics. A bendable, scalable multi-sensory skin will be developed. It has the ability of sensing directional tactile force, magnetic field, pressure, sound, distance, temperature, and heat flux at the same time. It uses the same basic structure and material for all sensory functions. It is expected to open up a large variety of not yet achievable research topics, such as for example safe physical human interaction machines, prosthetics with real sensory experience, human augmentations, remote experience, smart walls and furniture. Each of it could become a hot topic in the future to address pressing challenges in our society. We are sharing a common vision to combine science and engineering as well as fundamental and applied research, leading to new commercialized products and visible improvements to everyday life.



Multi-Sensory Flexible Skin

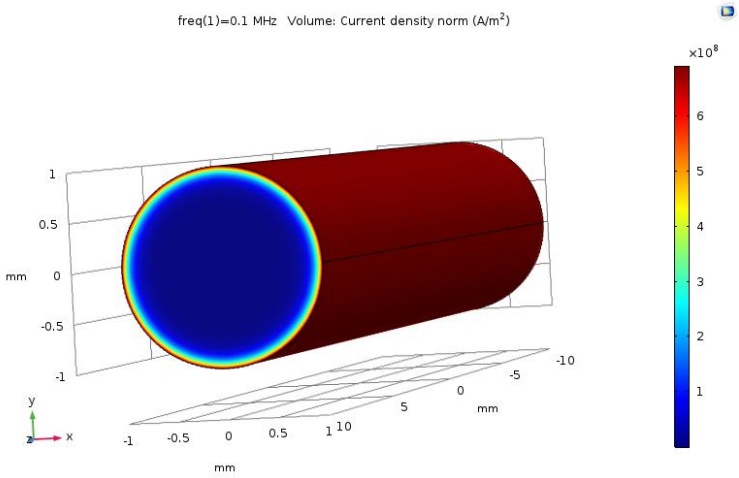
Topic for FY2020

- Discovery of mechanical stress induced switching in magnetic properties of amorphous FeSiB alloy:



$$\frac{\partial \mu_r}{\partial \sigma} > 0 \qquad \frac{\partial \mu_r}{\partial \sigma} < 0$$

- Implementation of the model of impedance-permeability-stress dependence in a FEM simulation for understanding electro-magneto-mechanical coupling:



$$Z = R_{DC}\frac{u}{2}\frac{J_0(u)}{J_1(u)} + i\omega L \qquad u = \sqrt{i^3 2\frac{a}{\delta(\sigma)}}$$

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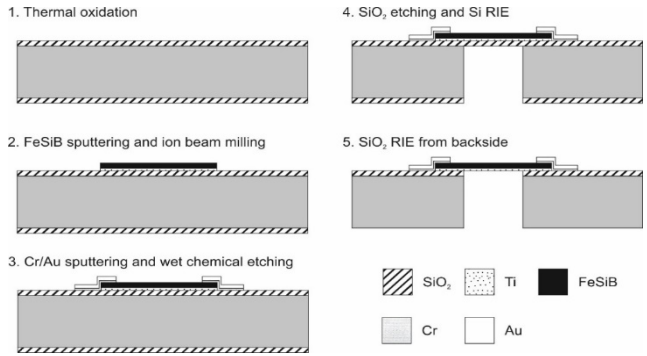
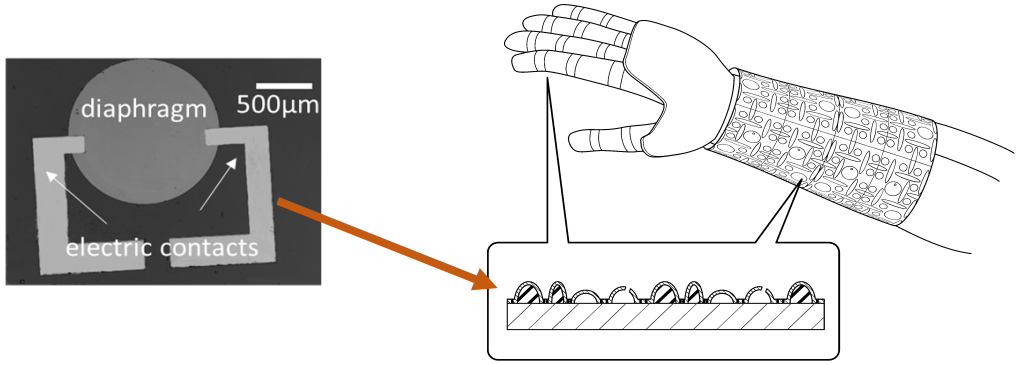
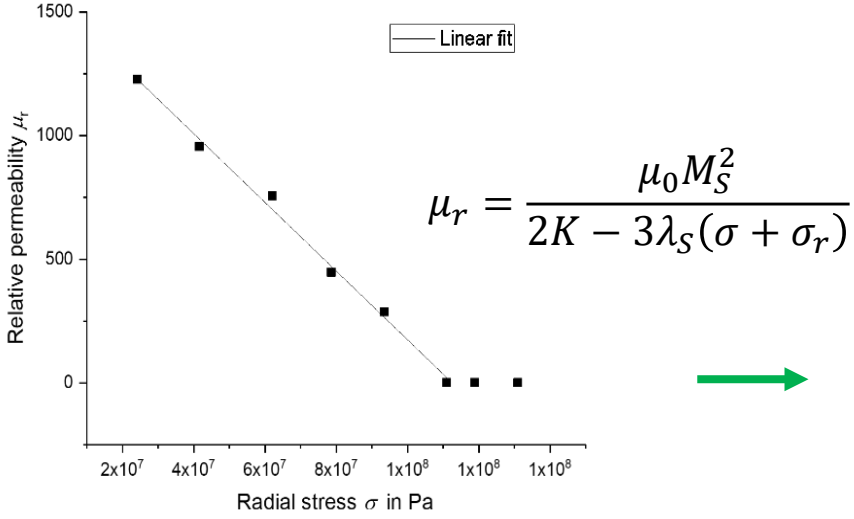
Topic for FY2019

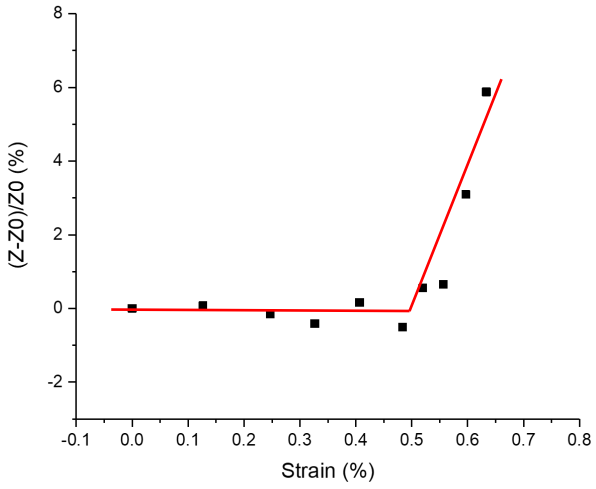
- Proof of small size, thin film sensor based on magneto-elastic coupling with very high gauge factor:







$$\mu_r = \frac{\mu_0 M_S^2}{2K - 3\lambda_S(\sigma + \sigma_r)}$$



Multi-Sensory Flexible Skin

Topic for FY2020

- Exoskeleton device fabrication with bending sensors and its evaluations
  - For our international collaboration, we have designed and fabricated a exoskeleton device with multiple sensors for precise human body control
- Development of an exoskeleton device fabrication method considering complex human shape
  - For precise and comfortable installation of exoskeleton devices, we developed a design and fabrication method
- Development of texture sensing with combination of active sensing and MEMS-CMOS integrated device
  - By using this system, we successfully measured paper surface (texture) difference