RF NEMS Magnetoelectric Sensor Simulation And Demonstration

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Introduction: RF NEMS Magnetoelectric (ME) Sensor with a ferromagnetic (FeGaB) / piezoelectric (AlN) thin film heterostructure is simulated, fabricated and measured in this work. To analyze the response of the ME structures, the coupling between the magnetic, elastic and electric field in the two different magnetostrictive and piezoelectric effects should be taken into consideration.

Computational Methods:

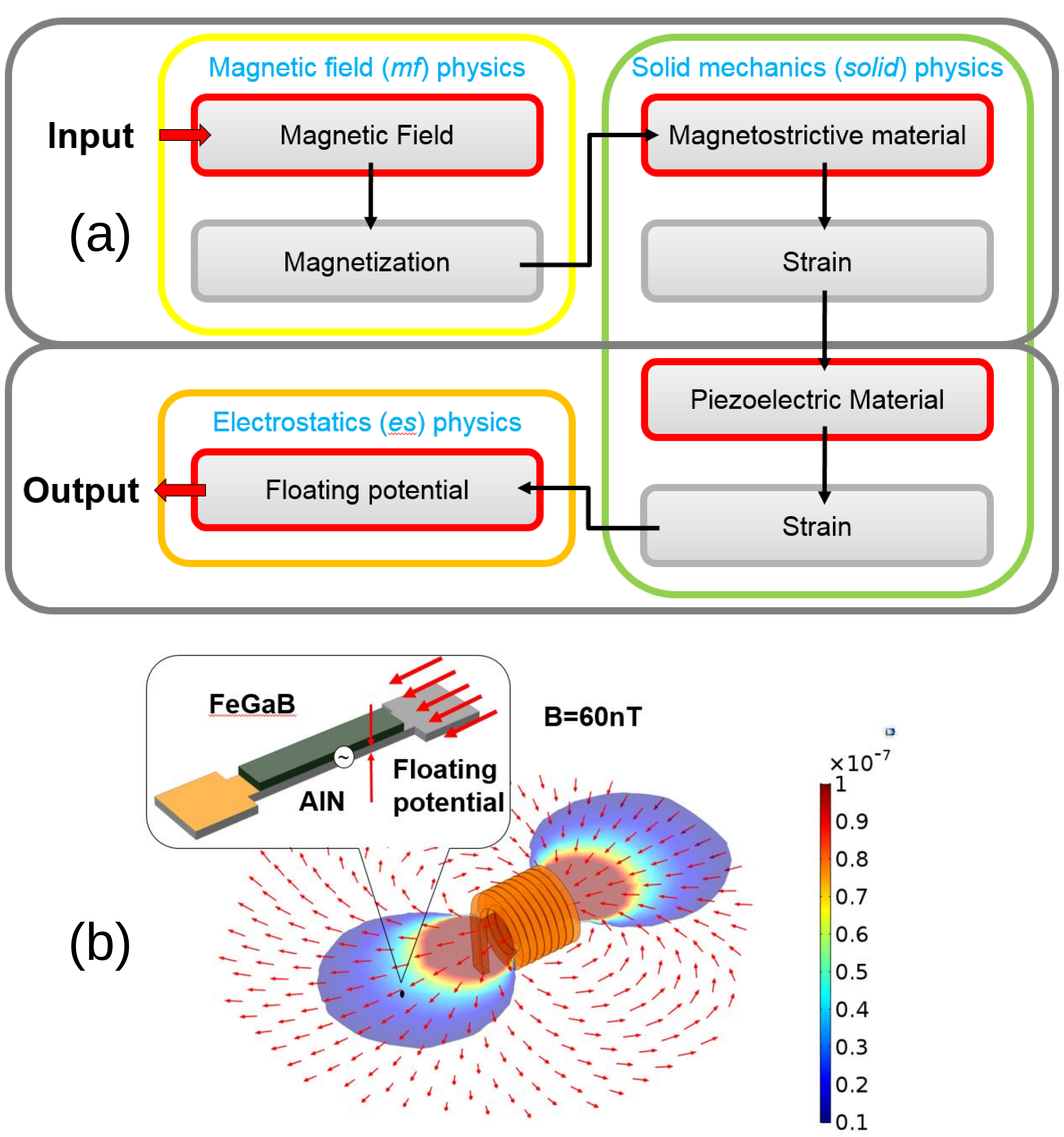

Figure 1. (a) Simulation process flow. Coupling (b) Simulation setup.

Results: The ME sensors was fabricated using a five-mask CMOS microfabrication process. The RF magnetic field is generated by a RF coil soldered on SMA port and connected to the out-put port of the lock-in amplifier. The simulation of direct ME coupling induced voltage generated by ~60 nTesta RF magnetic field was about 118µV which was comparable to the experimental results 180µV at~60MHz.

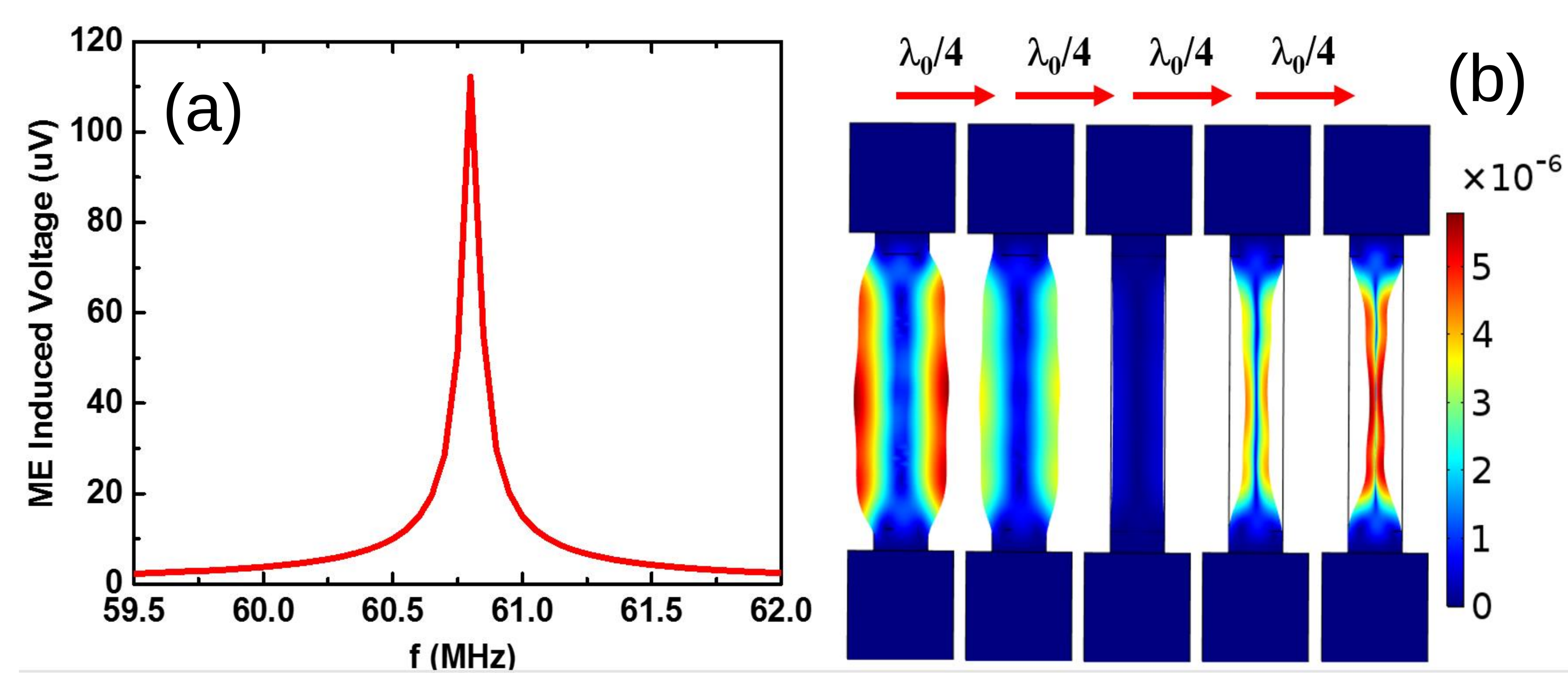

Figure 2. (a) Simulated induced voltage by Direct ME Coupling (b) Displacement profile of the ME resonator.

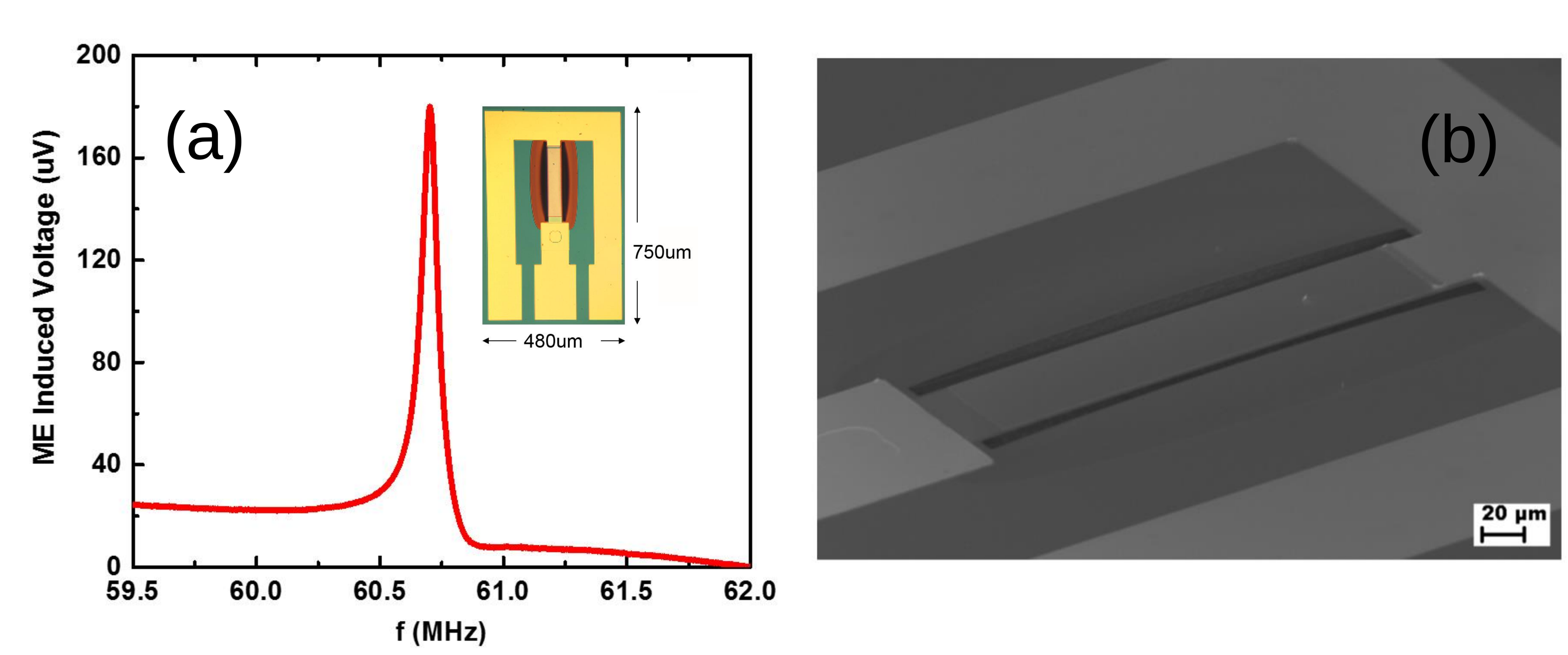

Figure 3. (a) Measured induced voltage by Direct ME Coupling and the optical image (b) SEM of the ME sensor.

Conclusions: The Direct Magnetoelectric coupling simulation capability by COMSOL® is expected to have great impacts on our future communication systems for internet of things (IoT), wearable sensors, bio-implantable and bio-injectable sensors, smart phones, wireless communication systems, etc.

References: T. Nan et al., Acoustically actuated ultra-compact NEMS magnetoelectric antennas, ***Nature Communications***, *8, 296*