Surface acoustic wave (SAW) tunable diffraction grating for hyperspectral imagers

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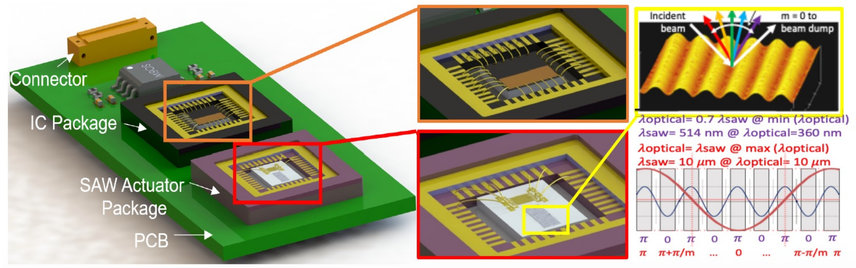
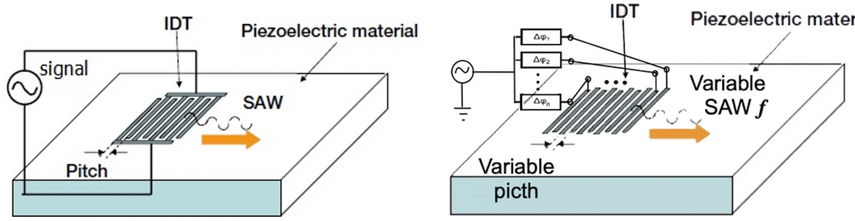
Program: FY21 R&TD Topics **Strategic Focus Area: Remote/In Situ/Life Detection Sensors and Instruments**

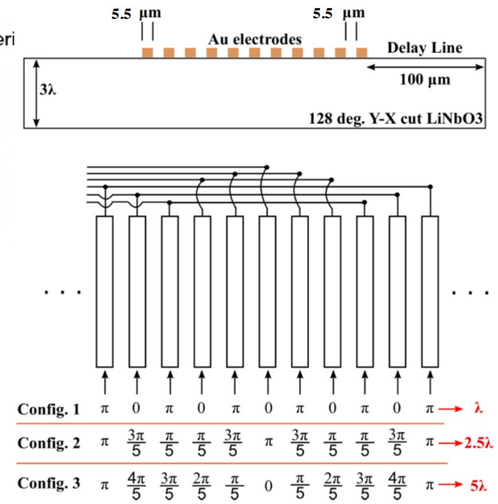
- Grating-based imaging spectrometers are some of the most common remote sensing instruments in the Planetary, Earth, and Astrophysics Sciences.
- In all current instruments, the diffraction grating is machined such that once it is patterned, the pitch is set and cannot be changed. For this same reason, to cover a wider spectral range, a number of diffraction gratings are needed
- In this project, we developed surface acoustic wave (SAW) tunable diffraction grating that enable spectrometers with high resolving power, over several octaves of wavelengths, without trading off spatial resolution.
- We use the delay line of a SAW device as the tunable grating. To tune the pitch of the grating, we change the frequency of the SAW by applying different phase shifts to the IDT electrodes.
- This grating can lead to a new class of spectrometers that are sensitive over a large wavelength range (360 nm to 10 um).
- Such instruments would enable improved science at planetary bodies across the solar system than the currently available technology achieves.



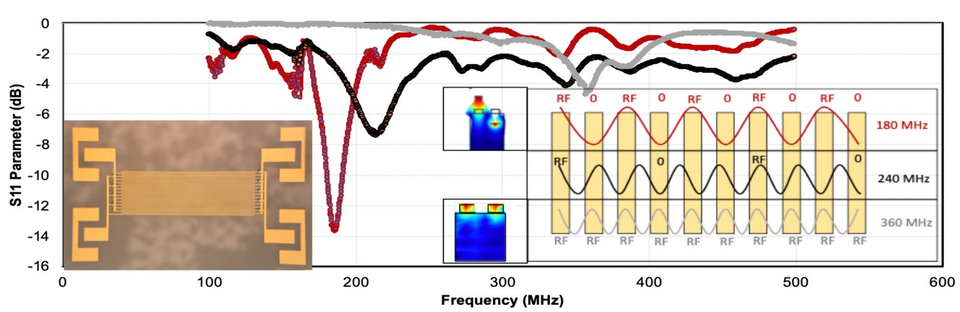
A schematic showing the device principle of operation. Instead of engraving gratings, the gratings are defined using surface acoustic wave. By tuning the frequency of the acoustic signal and/or changing the phase applied to the SAW actuator fingers, the pitch of the grating is changed to maximally diffract the optical band of interest.



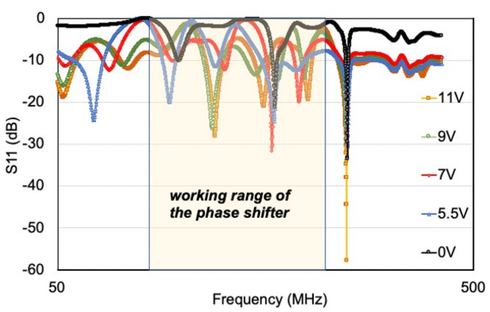
LEFT: a conventional SAW delay line, RIGHT: a schematic showing the concept of the tunable SAW actuator.



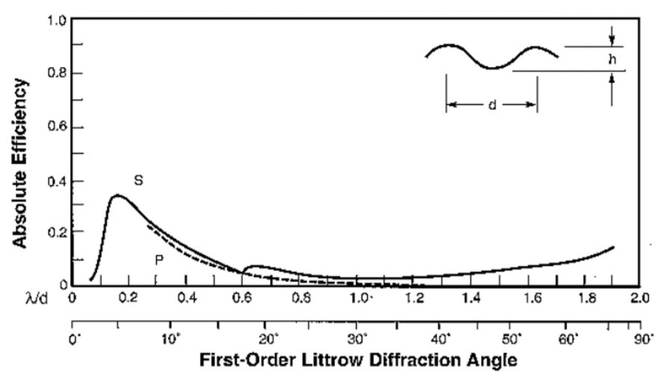
2D schematic of the SAW device detailing the dimensions and materials used. (b) Three input configurations used in the simulations. In each configuration, input signals with the listed phases are applied to the designated electrodes to modify the resonance frequency and wavelength of the SAW device.



Measurement results of tunable SAW actuator on lithium niobate (without the phase shifter attached). The frequency response is tuned by changing the configuration of IDTs as shown in the inset. A picture of the fabricated tunable SAW device is also shown. The frequency is tuned from 180 MHz to 360 MHz.



Measured S11 parameter of the SAW transducer as a function of the applied bias to the phase shifter.



1st order theoretical efficiency curve: SAW peak to peak amplitude (h)/ Lamda(SAW)(d) = 0.05 and Littrow mounting for s-polarized and p-polarized light.

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