National Aeronautics and Space Administration

SURFACE ACOUSTIC WAVE (SAW) TUNABLE DIFFRACTION GRATING FOR HYPERSPECTRAL IMAGERS

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Program: Topical RTD

Project Objective:

- The goal of this project is to develop surface acoustic wave (SAW) tunable diffraction grating that enable spectrometers with high resolving power, over several octaves of wavelengths, without trading off spatial resolution, in one self-contained module, and
- without a wheel mechanism.
- The proposed tunable pitch diffraction grating will lead to a new class of spectrometers that are sensitive
- over a large wavelength range (360 nm to 10,000 nm). Such instruments would enable improved science at planetary bodies across the solar system.

Benefits to NASA and JPL (or significance of results):

- Grating-based imaging spectrometers are some of the most common remote sensing instruments in the Planetary, Earth, and Astrophysics Sciences.
- In all instruments used in current/planned missions, the diffraction grating is machined such that once it is patterned, the pitch is set and cannot be changed. To cover a wider spectral range, a number of diffraction gratings are needed.
- The proposed device reduces SWaP+C and adds new capabilities to the imaging spectrometers.
- Expanding the measurement capabilities without adding to the system SWaP will make JPL more competitive in the competed missions in all Earth, Planetary, and Astrophysics science disciplines.

FY 19 Results:

- The SAW delay line acts as the diffraction grating (Fig.1). To tune the grating pitch the frequency of the SAW is tuned (Fig. 2).
- Demonstrated, for the first time, wide frequency tuning of SAW transducer by exciting different (phase of) IDT fingers (Fig. 4)
- Two new technology reports on the tunable diffraction grating concept. One on using a polymer to amplify the signal (Fig. 5) and one on using a metal-insulator transition material such as vanadium dioxide (Fig. 6). A metallic glass can also be used on the delay line (Fig. 6)

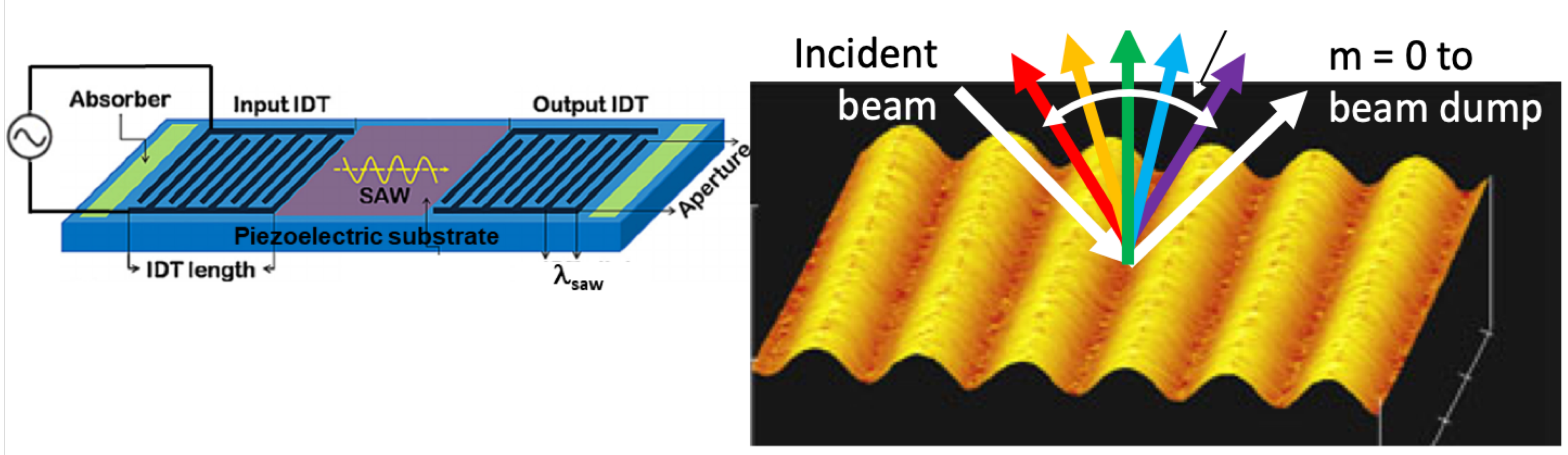

Figure 1. The SAW delay line is used as the diffraction grating in this work. A schematic showing the diffraction spectrum off of a grating.

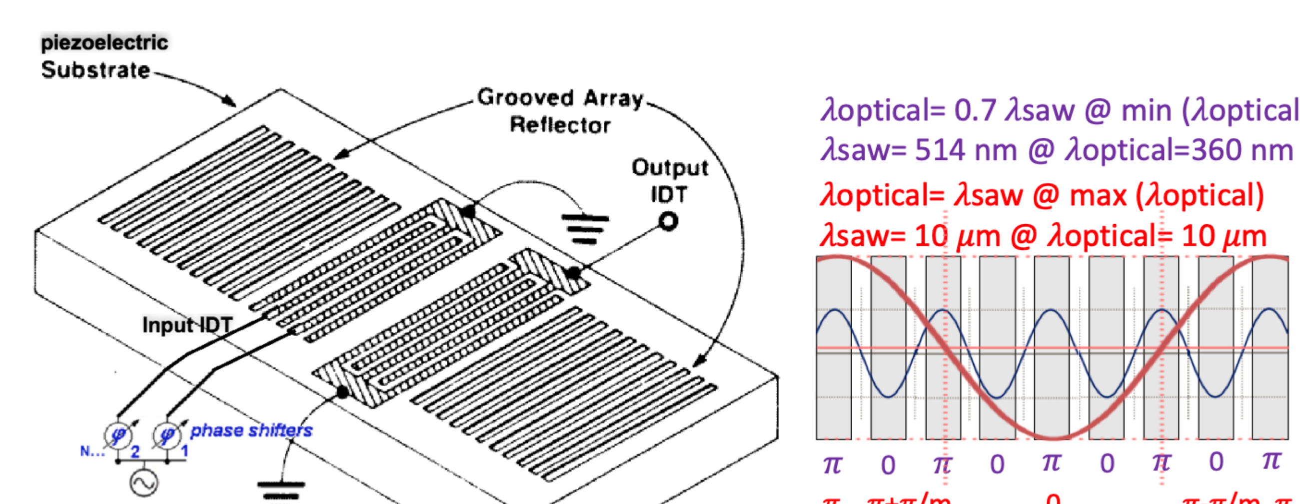

Figure 2. A schematic showing the tuning mechanism. To tune the pitch of the grating, the frequency of the SAW is changed by changing the phase applied to the IDT fingers.

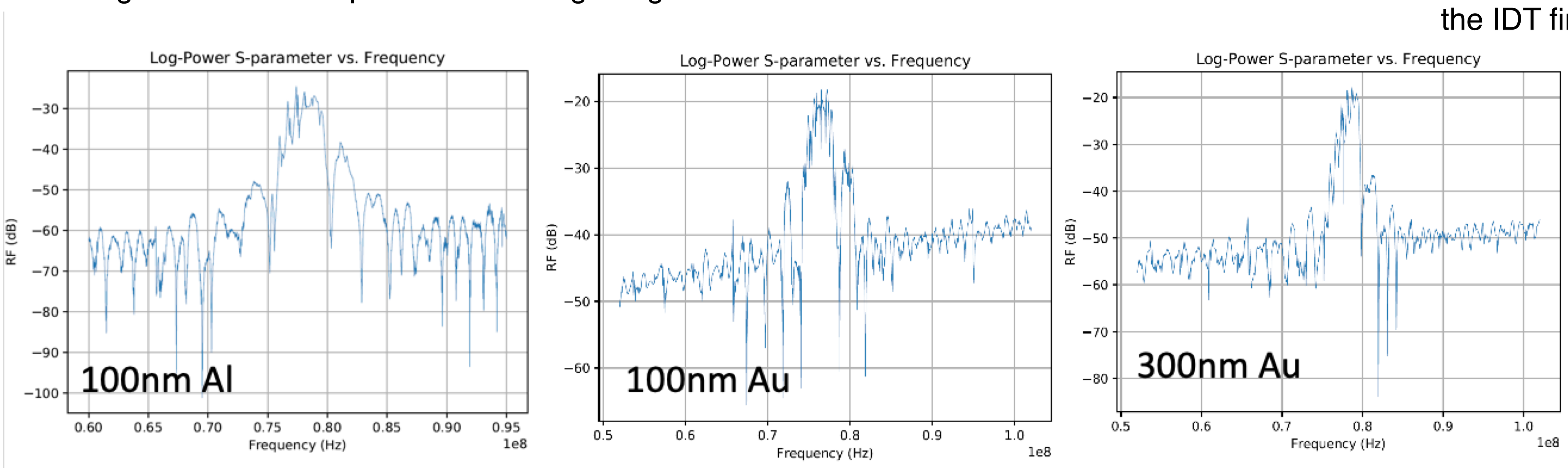

Figure 3. Measured results of three SAW transducers comparing different metals and thicknesses used for IDT fingers. 300nm Au is chosen due to its lower loss and ease of fabrication. The corresponding optical frequency is 4500 nm.

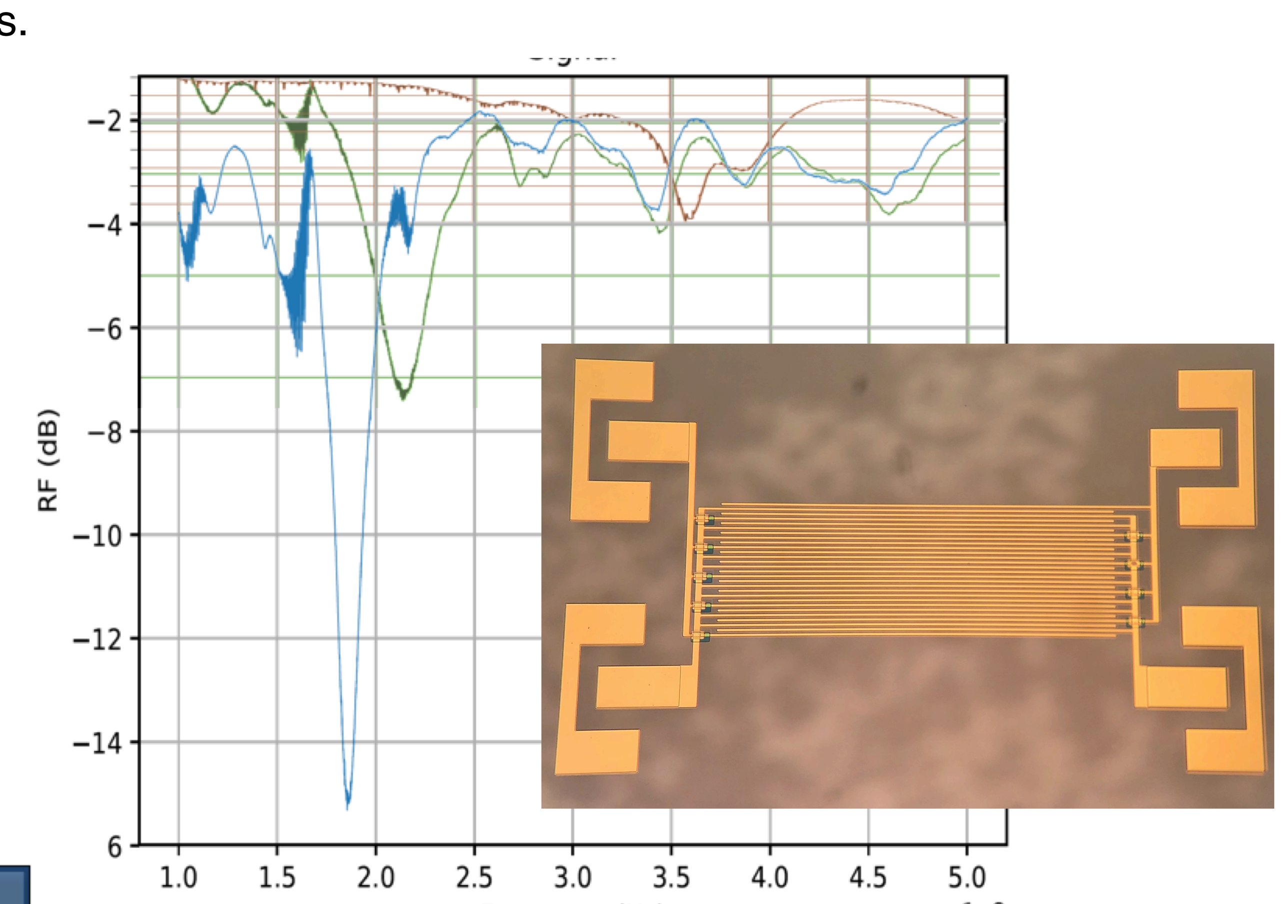

Fig. 4. Image and S11 response of a tunable SAW transducer with different IDT sets excited. The frequency is tuned from 185MHz (1/2 f0) to 213 MHz (2/3 f0) and 361 MHz (f0).

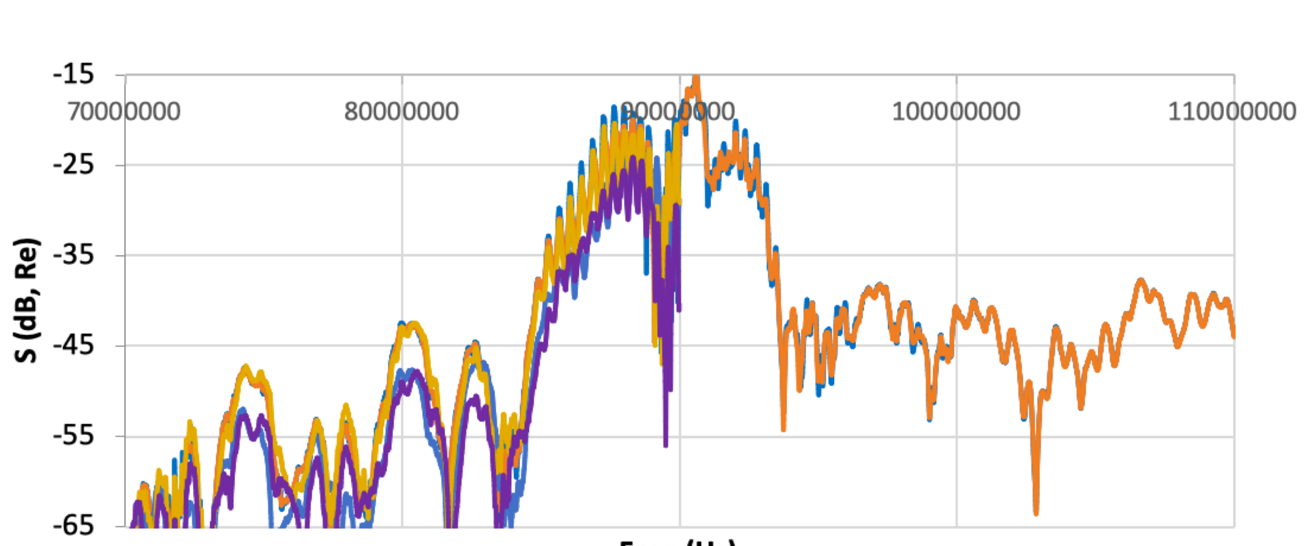

Figure 5. Measured response of a SAW filter with and without (blue) PDMS coating on the delayline, as an absorber (orange), and on the IDTs (purple). The change in response is insignificant.

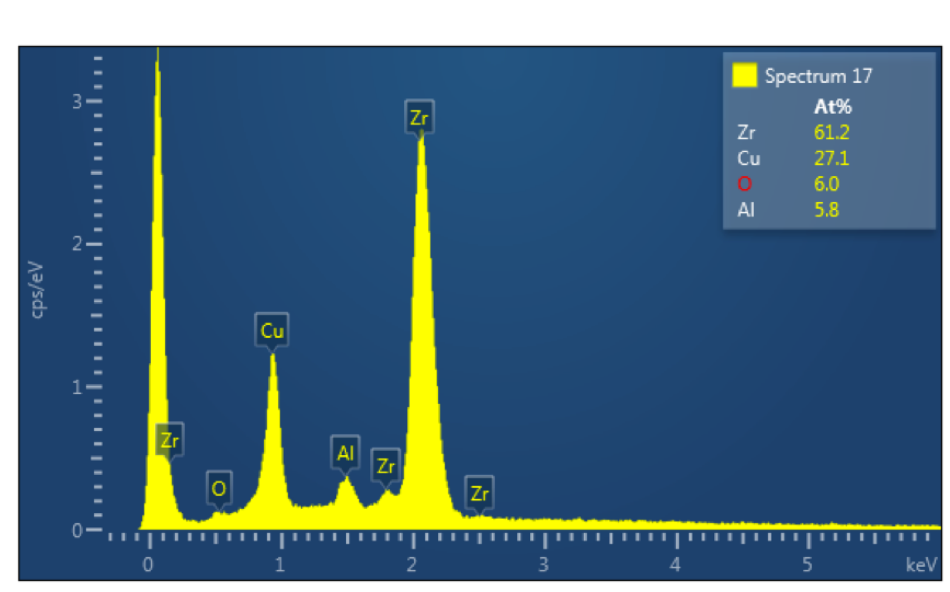

Figure 6. EDS result showing the composition of the bulk metallic glass deposited on lithium niobate.

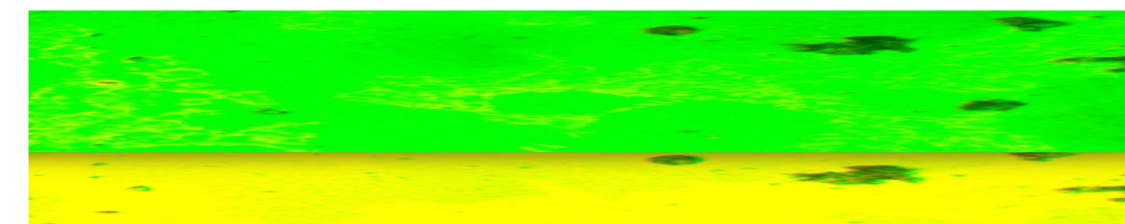

Fig. 7. The change in refractive index and hence the color of VO2 (top) after and bottom (before) the transition at 60C.

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