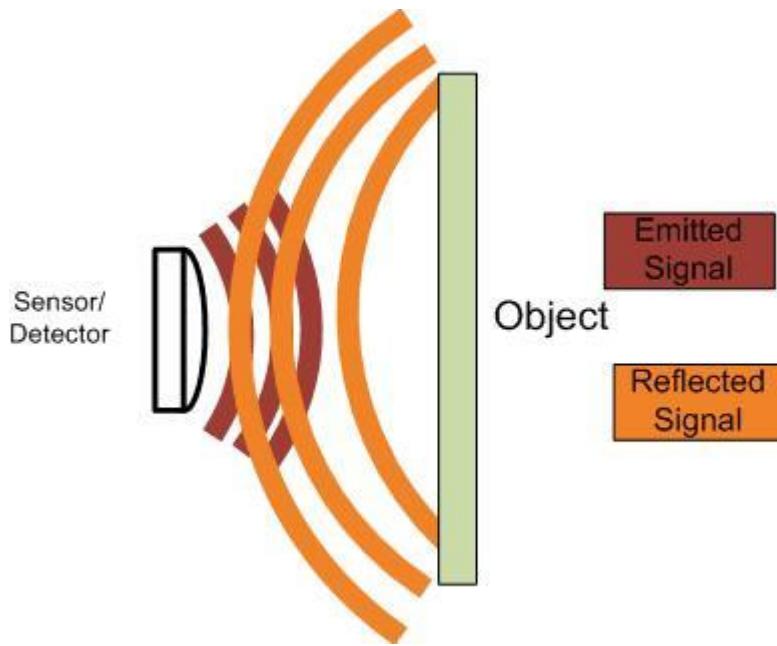


Surface Acoustic Wave (SAW) sensors detect pressure and humidity by using a piezoelectric substrate with a thin sensing film; changes in humidity or pressure alter the film's mass/elasticity, causing a measurable shift in the SAW's frequency, offering small size, high sensitivity, and potential for wireless sensing, with recent advances incorporating materials like graphene oxide or MXene for improved performance across wide ranges.



How They Work (Humidity)





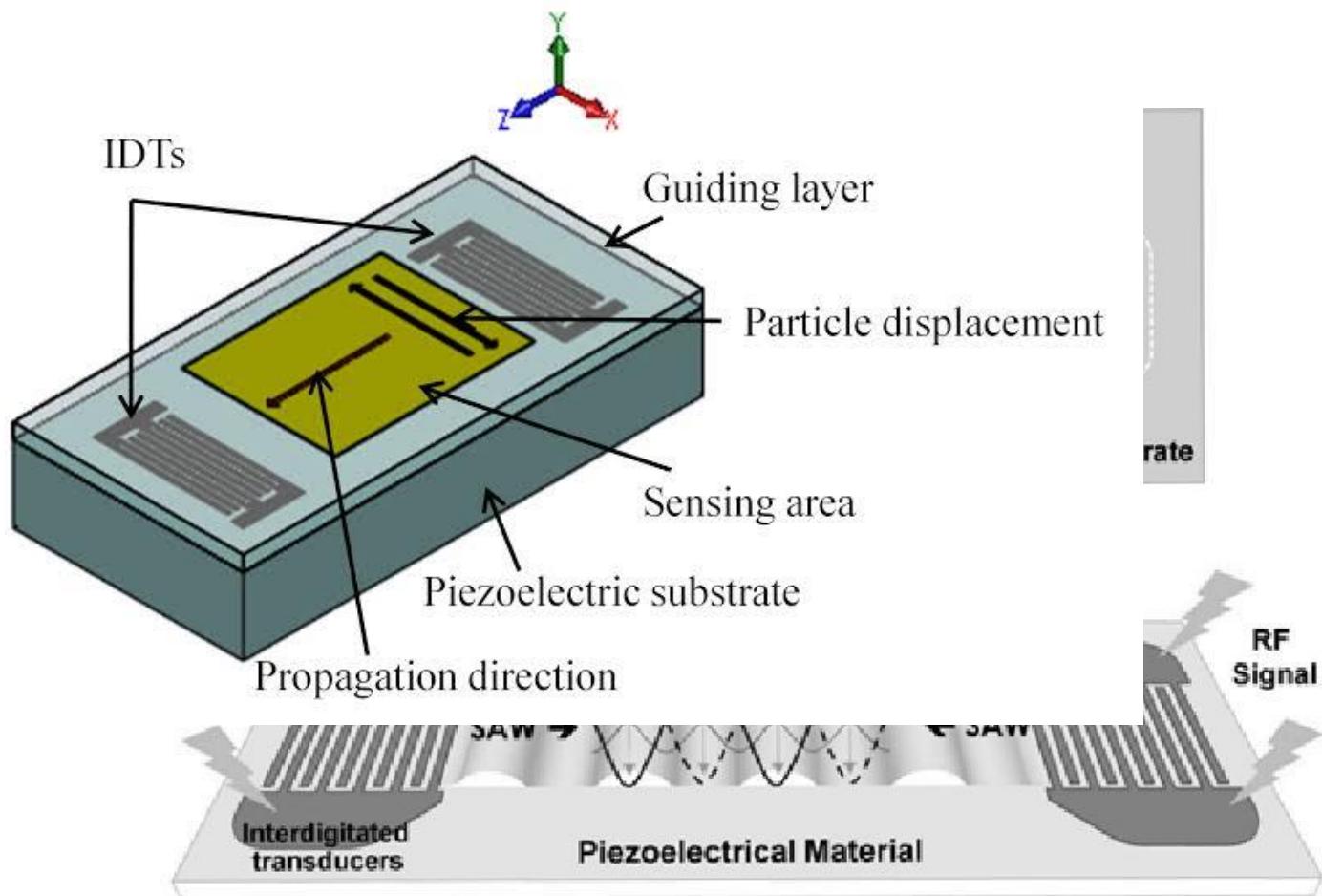
- **Sensing Mechanism:** A layer of moisture-absorbing material (e.g., polymer, metal oxide, graphene) coats the SAW device.
- **Adsorption:** Water molecules adsorb onto or into this film as humidity changes.
- **Frequency Shift:** This increases the film's mass ([mass-loading](#)) or alters its mechanical properties ([elasticity/viscoelasticity](#)), slowing down the SAW and shifting its resonant frequency.
- **Detection:** A decrease in frequency typically indicates an increase in humidity.

How They Work (Pressure)

- **Mass Loading/Stress:** Similar to humidity, pressure changes can physically deform the sensing film or substrate, changing the wave's velocity.
- **Integrated Sensing:** Advanced SAW sensors can combine materials (like MXene/MoS₂) to simultaneously detect temperature, pressure, and humidity within a single device.

Key Advantages

- **High Sensitivity:** Can detect small changes, with recent sensors showing high



kHz/%RH sensitivity.

- **Small Size & Wireless:** Suitable for miniaturization, integration, and potentially wireless, passive operation (like torque sensors).
- **Fast Response:** Modern designs offer rapid response and recovery times.
- **Robustness:** Can operate in demanding conditions, with some achieving wide temperature and pressure ranges.

Sensing Materials (Examples)

- **Humidity:** Graphene Oxide (GO), metal oxides (ZnO), polymers (PDEB, NaSPF).
- **Multi-Parameter:** MXene@MoS₂@Go composites for TPH sensing.

Applications

- Industrial process control, automotive, medical, environmental monitoring, agriculture, and even skin moisture detection.

