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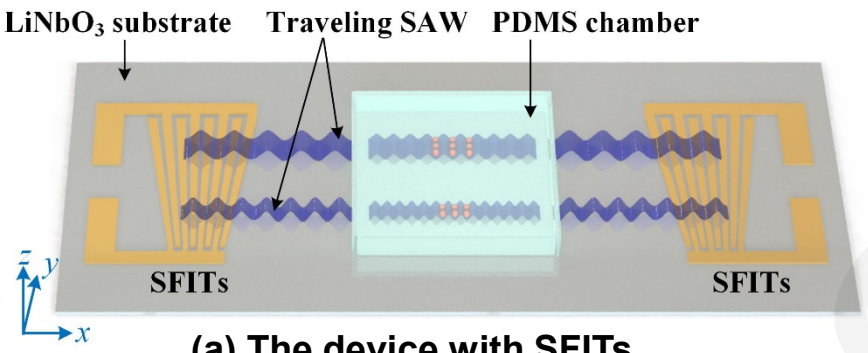
Tunable patterning of microscale particles using a surface acoustic wave device with slanted-finger interdigital transducers

Yan-cheng WANG, Cheng-yao XU, De-qing MEI, Jia-wei LIU

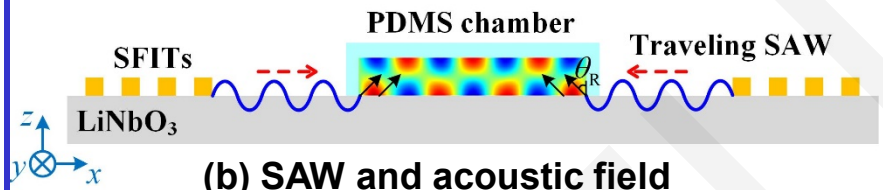
Key words:

Tunable patterning; Surface acoustic wave (SAW); Acoustic pressure field; Polymer-based composite; Slanted-finger interdigital transducers

Working Principle



(a) The device with SFITs



(b) SAW and acoustic field

Fig. 1 Working principle

$$F_r = -\left(\frac{\pi p_0^2 V_p \beta_m}{2\lambda}\right)\phi(\beta,\rho)\sin(2kx) \qquad \phi(\beta,\rho) = \frac{5\rho_p - 2\rho_m}{2\rho_p + \rho_m} - \frac{\beta_p}{\beta_m}$$

Patterning principle

- Localized piezoelectric effect
- Acoustic field in chamber
- Acoustic radiation force on particles

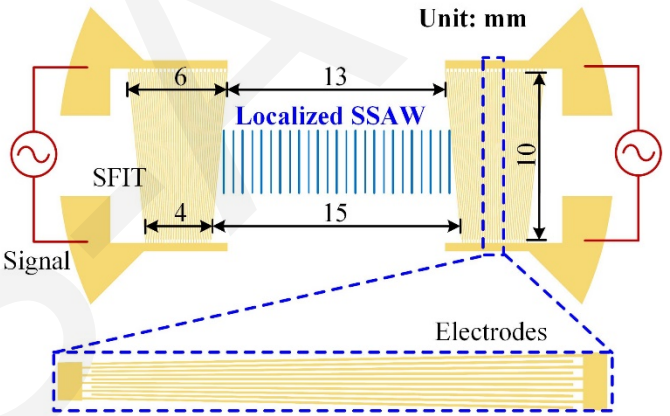


Fig. 2 Structure of the SFITs

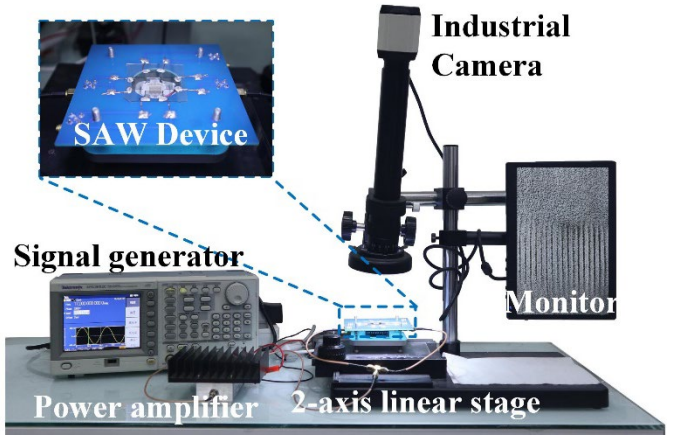
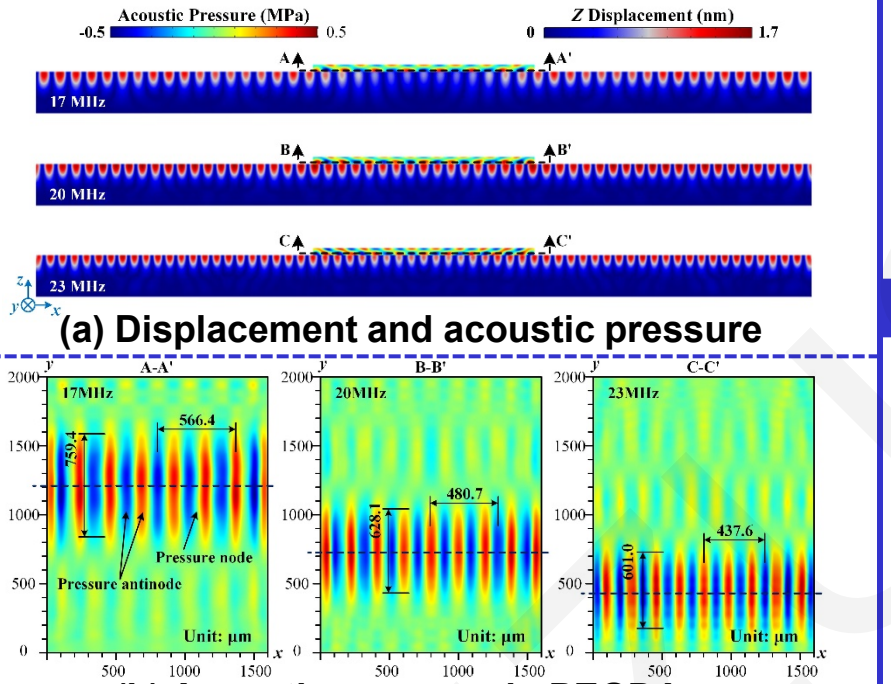


Fig. 3 Experimental setup

Results and Discussion

■ Simulation Results



(a) Displacement and acoustic pressure

(b) Acoustic pressure in PEGDA

Fig. 4 Simulation of single signal

☐ Results

- Surface acoustic wave was excited in a narrow region, and propagated along the x direction.
- The period of the acoustic pressure field decreased as the frequency increased.
- The width of the acoustic pressure field also tended to decline.

☐ Results

- Two regions of patterned pressure fields were generated with multi-signal.

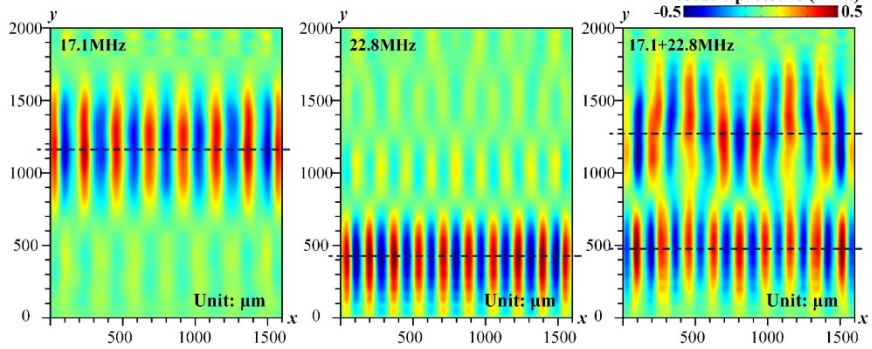
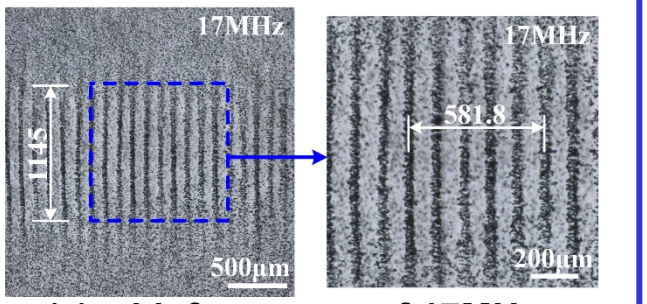


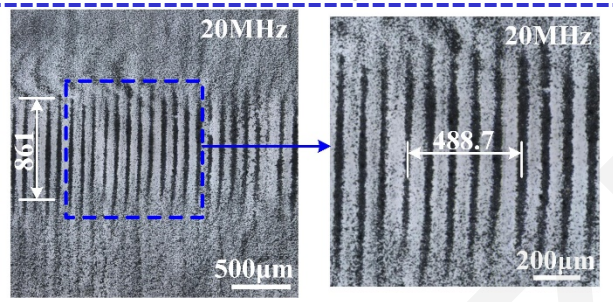
Fig. 5 Simulation of multi-signal

Results and Discussion

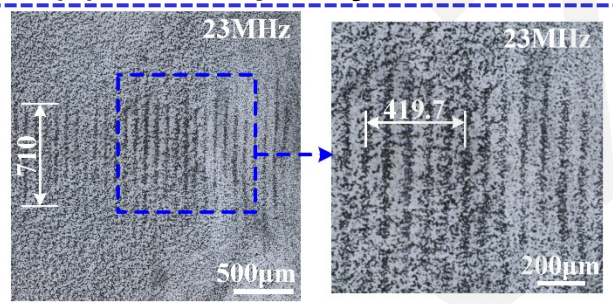
Experimental Results



(a) with frequency of 17MHz



(b) with frequency of 20MHz



(c) with frequency of 23MHz

Fig. 6 Patterning of single signal

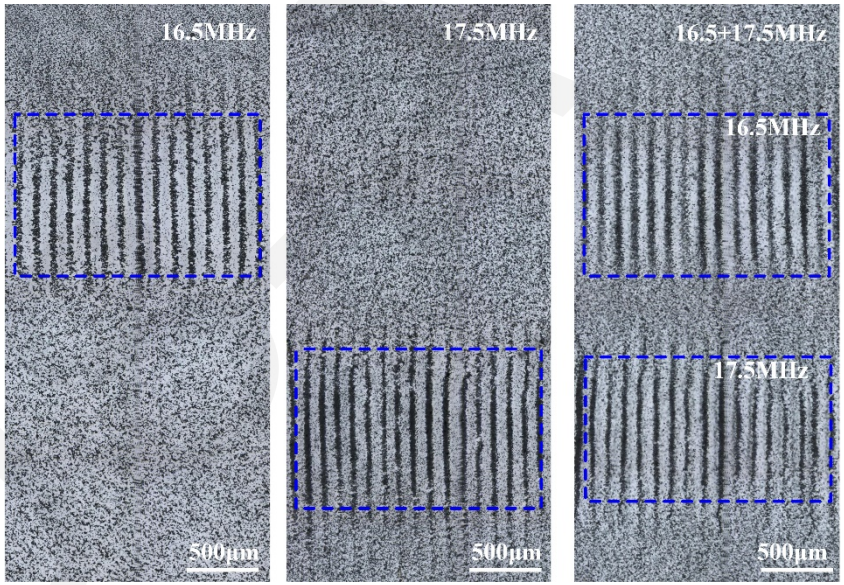


Fig. 7 Patterning of multi-signal

Results

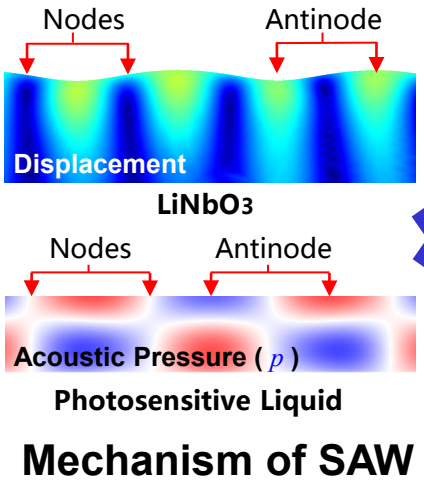
- Particle patterning with a period around 83.9 to 116.4 μm, and a width of about 710 to 1145 μm can be achieved.
- Particles can be patterned into different patterning in one sample.

Conclusions and Future Work

Conclusions

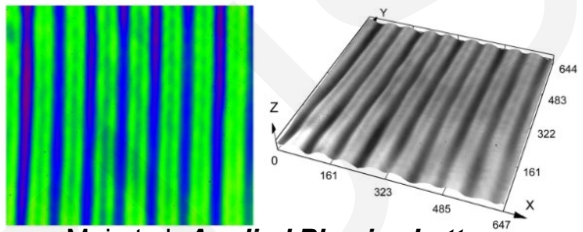
- The method based on a SAW device with slanted-finger interdigital transducers (SFITs) can achieve tunable particle patterning with a period shifting from around 83.9 to 116.4 μm, and a width of about 710 to 1145 μm.
- The period and width of pattern decrease with the frequency increasing, and the period is about half the wavelength of the surface acoustic wave.

Future work

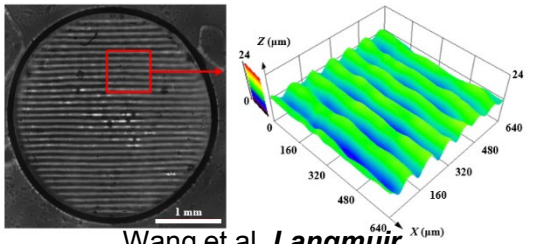


Mechanism of SAW

Microstructure

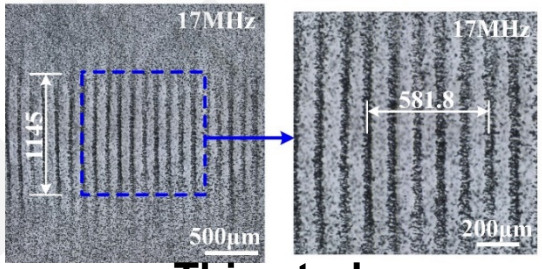


Mei et al. ***Applied Physics Letters***, 2016, 108(24): 241911-4.

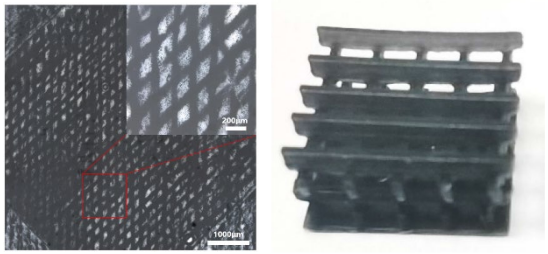


Wang et al. ***Langmuir***, 2019, 35(34): 11225-11231.

Particle patterning



This study



Acoustic assisted 3D printing

We'd like to apply SAW methods to additive manufacturing!