Supplementary Material

Droplet Delivery and Nebulization System Using Surface Acoustic Wave for Mass Spectrometry

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S1 Simulation matrix

The strain-charge form is useful for analyzing actuators and the stress-charge form is useful to analyze vibration and waves. We use the stress-charge form for our simulation. The strain-charge form can be written as:

$$\vec{S} = \vec{s_E} \cdot \vec{T} + \vec{d}^T \cdot \vec{E}$$

$$\vec{D} = \vec{d} \cdot \vec{T} + \vec{\varepsilon} \cdot \vec{E}$$

where $\vec{S}$ is the strain (m/m), $\vec{T}$ is the stress (N/m^2), $\vec{D}$ is the electric displacement (C/m^2), $\vec{E}$ is the electrical field (V/m), s_E is the elastic compliance coefficient (m^2/N), $\vec{d}$ is the piezoelectric stress coefficient (C/N) and ϵ is the dielectric constant (F/m).

For our substrate material $LiNbO_3$, the matrix used can be expressed as:

Elastic stiffness matrix:

$$\vec{c_{Eij}} = \begin{bmatrix} c_{E11} & c_{E12} & c_{E13} & c_{E14} & 0 & 0 \\ c_{E12} & c_{E11} & c_{E13} & -c_{E14} & 0 & 0 \\ c_{E13} & c_{E13} & c_{E33} & 0 & 0 & 0 \\ c_{E14} & -c_{E14} & 0 & c_{E44} & 0 & 0 \\ 0 & 0 & 0 & 0 & c_{E44} & c_{E14} \\ 0 & 0 & 0 & 0 & c_{E14} & c_{E66} = \dfrac{c_{E11} - c_{E12}}{2} \end{bmatrix}$$

Piezoelectric matrix:

$$\vec{e_{ij}} = \begin{bmatrix} 0 & 0 & 0 & 0 & e_{15} & -e_{22} \\ -e_{22} & e_{22} & 0 & e_{15} & 0 & 0 \\ e_{31} & e_{31} & e_{33} & 0 & 0 & 0 \end{bmatrix}$$

Dielectric matrix:

$$\vec{\varepsilon_{ij}} = \begin{bmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{11} & 0 \\ 0 & 0 & \varepsilon_{33} \end{bmatrix}$$

The coefficient of $LiNbO_3$ used for the simulation is from the reference [1], shown in the table below:

Table.1 Elastic Stiffness Coefficient (GPa)

C_{11}	C_{12}	C_{13}	C_{14}	C_{33}	C_{44}
199	53.8	71.4	7.85	237.2	60.1

Table.2 Piezoelectric Coefficient (C/m^2)

e_{15}	e_{22}	e_{31}	e_{33}
3.65	2.39	0.31	1.72

Table.3 Dielectric Constant (pF/m^2)

ε_{11}	ε_{33}
398.9	232.2

Reference

[1] K.-K. Wong, *Properties of Lithium Niobate* (no. 28). IET, 2002.

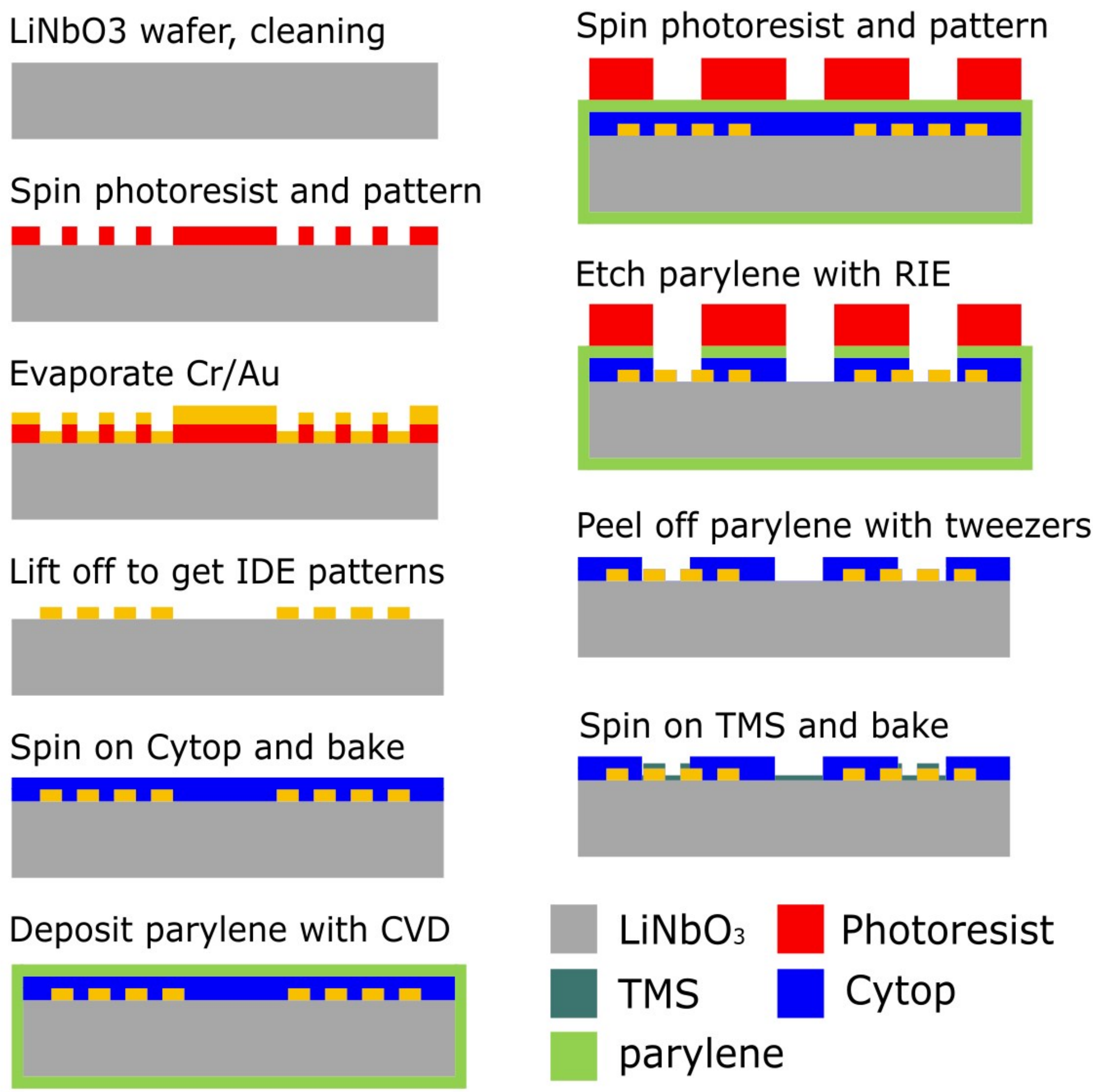

FIG S1. The fabrication process of the SAWN platform with ARC patterns. Parylene is used as the stencil mask without degrading the Cytop hydrophobicity after being peeled off.

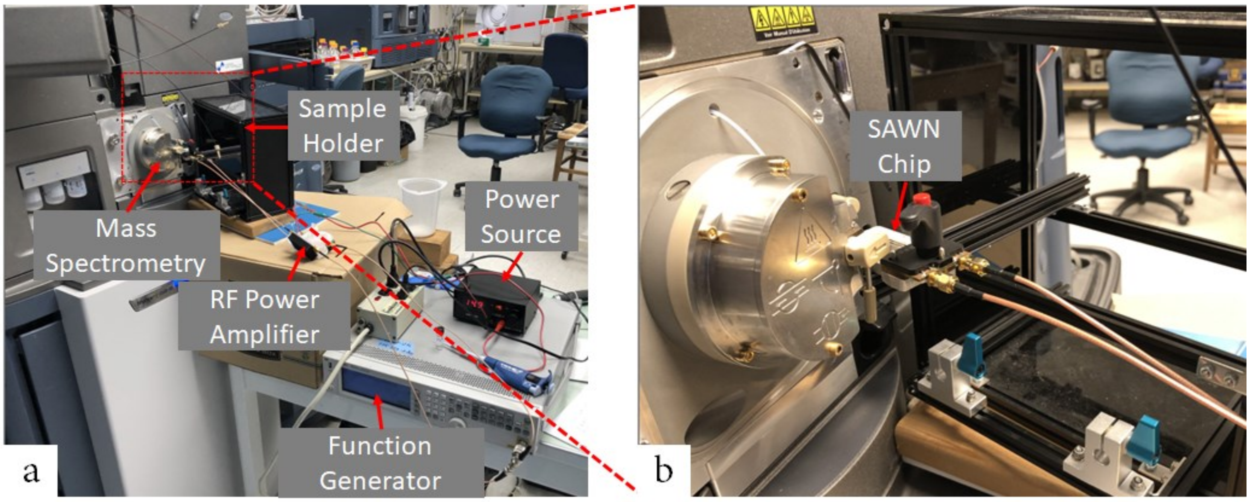

FIG S2. (a) Experimental setup for mass spectrometry measurement. (b) A close look at the sample holder and the SAWN chip mounted close to the mass spectrometer inlet. The mass spectrometry front cover was removed.

Movie S1. Droplet transport with SW-SAW and ARC

Movie S2. Droplet nebulization