

A 65-nm CMOS Fully-Integrated Circulating Tumor Cell and Exosome Analyzer Using an On-Chip Vector Network Analyzer and a Transmission-Line-Based Detection Window

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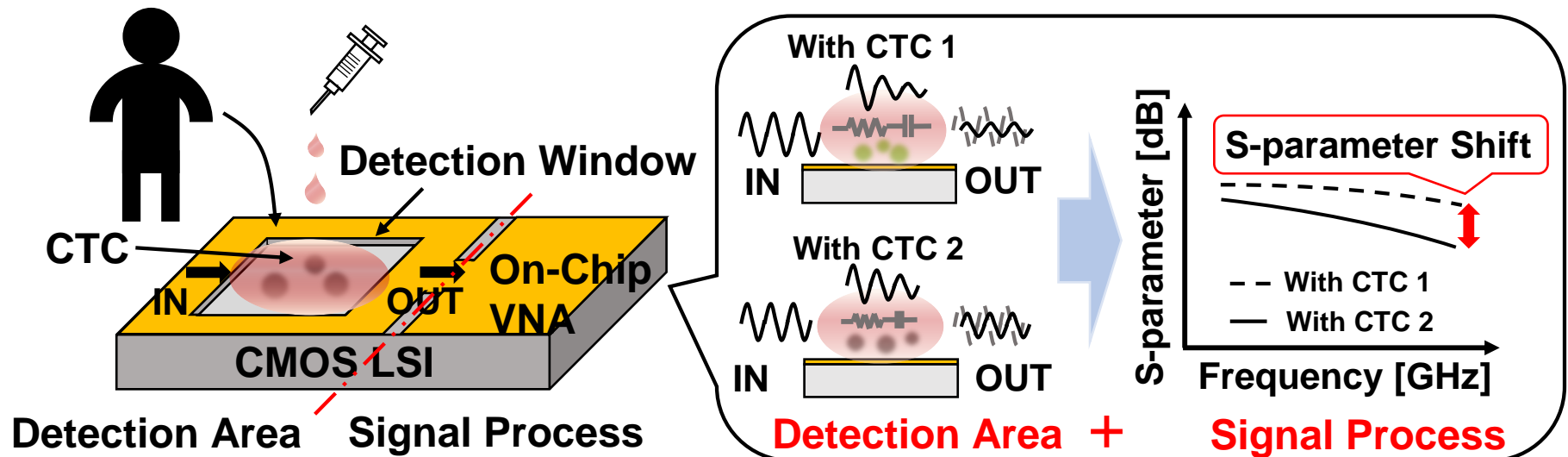
Background & Research object

■ Circulate tumor cell (CTC)

Cell detached from primary tumors and circulating in the bloodstream, which is a potential cancer biomarker

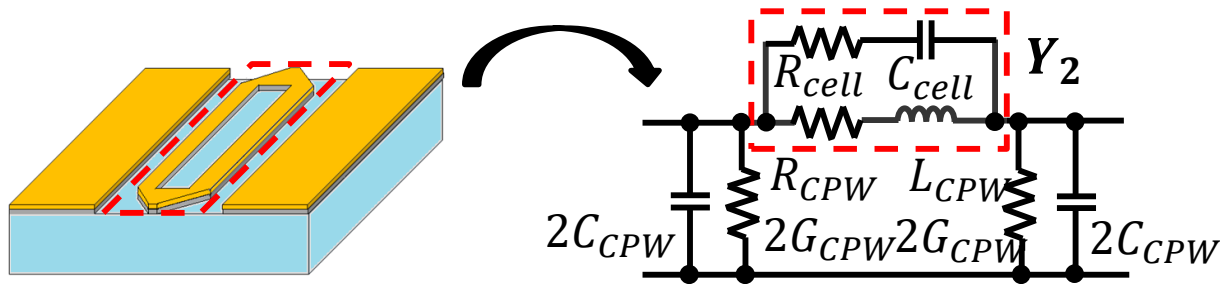
■ Research object

Realization of CMOS fully-integrated CTC analyzer



CTC analysis principle

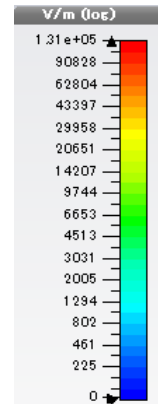
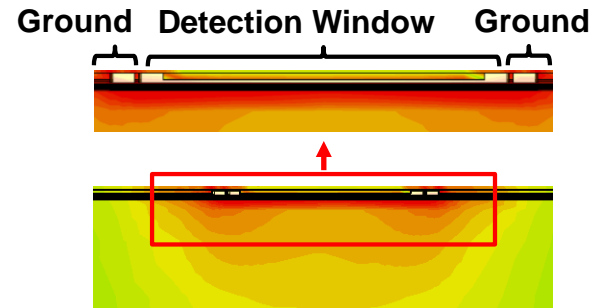
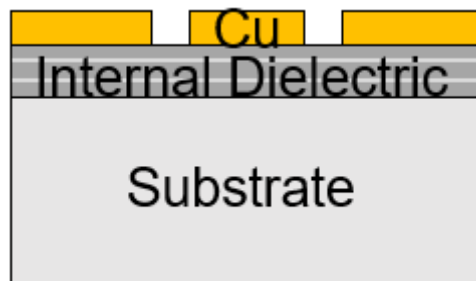
■ Transmission-line-based detection window[1]



$$B = Z_0(f) \frac{(1 + S_{11})^2 - S_{21}^2}{2S_{21}} = \frac{1}{Y_2}$$

S-parameters ↔ **CTCs' features**

■ Structure with CMOS technology

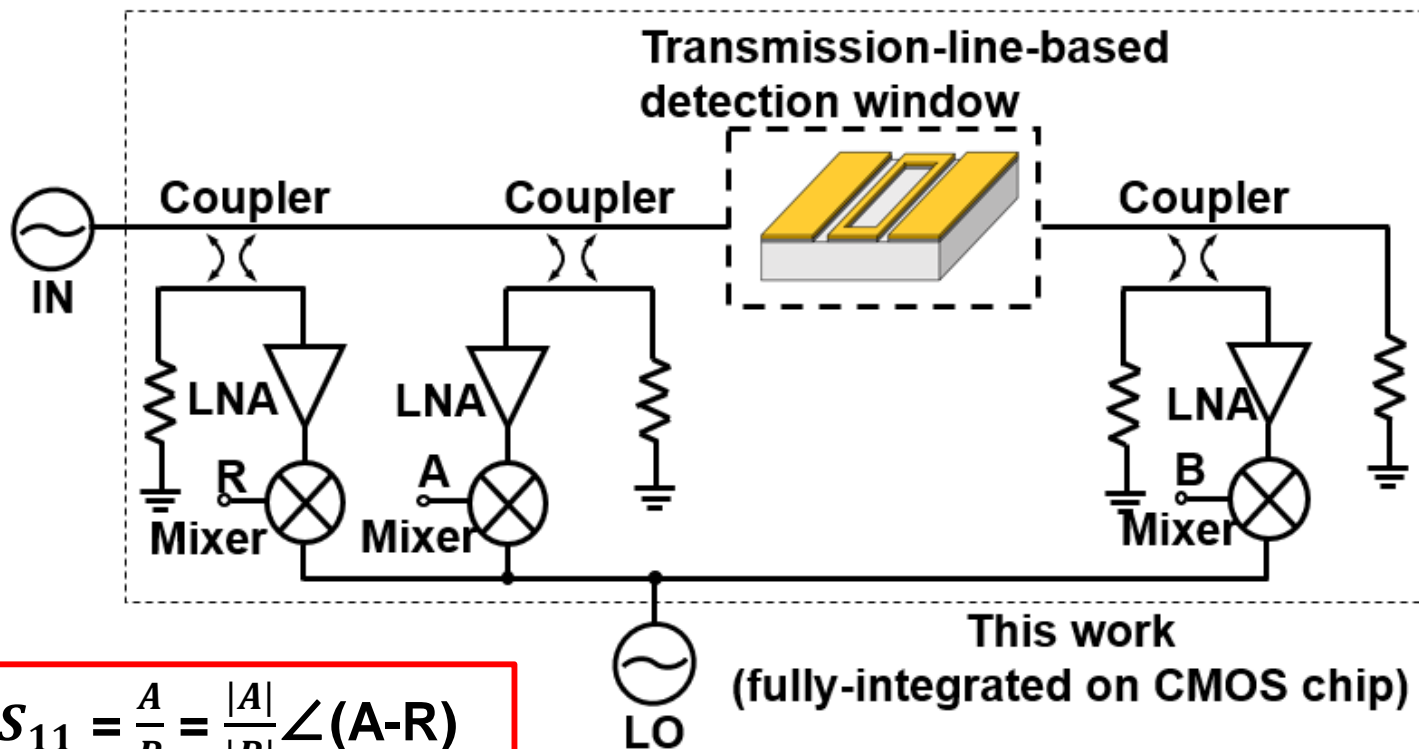


[1] H. W. Wu, "Label-Free and Antibody-Free Wideband Microwave Biosensor for Identifying the Cancer Cells," *IEEE Trans. Microw. Theory Techni.*, vol. 64, no. 3, pp. 982-990, Mar. 2016.

System architecture

■ Whole system

Transmission-line-based detection window + On-chip Vector network analyzer

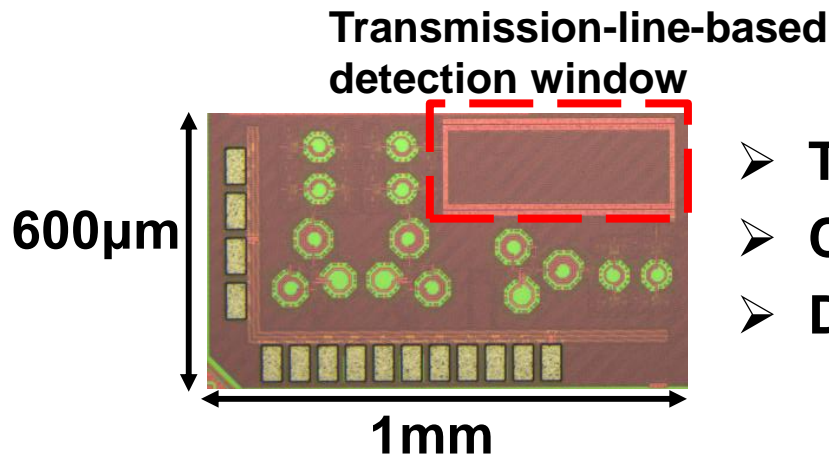


$$S_{11} = \frac{A}{R} = \frac{|A|}{|R|} \angle (A-R)$$

$$S_{21} = \frac{B}{R} = \frac{|B|}{|R|} \angle (B-R)$$

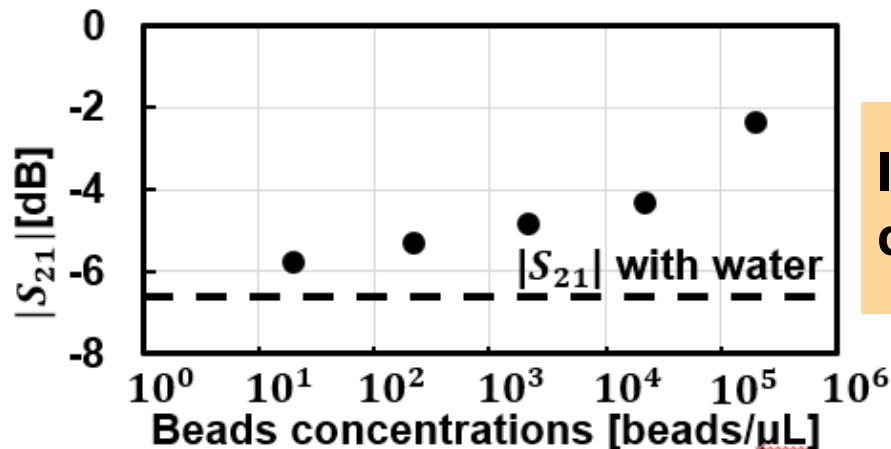
Chip microphotograph and measurement results

■ Chip microphotograph



- Technology: 65nm standard CMOS
- Chip: 600µm × 1mm
- Detection window: 190µm × 510µm

■ Measurement result (when beads are added)



It is confirmed the S-parameters depend on beads concentration