A SURFACE MOUNTABLE MEMBRANE SUPPORTED FILTER

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OUTLINE OF THE TALK

1) MICRO-MACHINED FILTER
   - WET ETCHING PROCESS
   - $Q_0$ MEASUREMENT
   - NARROW BAND FILTER

2) SURFACE MOUNTABLE FILTER
   - DESCRIPTION OF THE STRUCTURE

3) A 2 POLE 30 GHz MICRO-STRIP FILTER
   - DESIGN AND FABRICATION
TRANSVERSE SECTION

Metallization

Si

Via groove

Cavity height ($h_{\text{sup}}$)

Resonator width ($w$)

Lower cavity ($h_{\text{inf}}$)

ASSOCIATION OF 2 CAVITIES
ASSEMBLY

FABRICATION OF 2 CAVITIES WITH 3 MICROMACHINED SUBSTRATES

- Upper cavity
- Dielectric membrane
- Metallized via groove
- Lower cavity
MICRO-MACHINING OVERVIEW

😊 ADVANTAGES

PLANAR SOLUTION

SMALL SIZE

LOW COST

NO DISPERSION OR RADIATION

HIGH QUALITY FACTOR (600)

😊 NEED OF TRANSITION TO CONNECT IT
FABRICATION PROCESS

1) Si
   deposit of a resin layer in the upper and lower part

2) Exposure of the resin in the lower part

3) etching of the mask level in the lower part

4) Elimination of the resin

5) Selective etching of Si until the membrane is released
DIMENSION AND RESONATOR OPTIMIZATION

$Q_0 = f(h_{\text{sup}})$

- $w = 2 \text{ mm}$
- $w = 1 \text{ mm}$
- $w = 0.8 \text{ mm}$
- $w = 0.5 \text{ mm}$

$W = 2 \text{ mm}$
$h_{\text{sup}} = 0.425 \text{ mm}$
$h_{\text{inf}} = 0.76 \text{ mm}$

COMPUTED WITH ADS MOMENTUM
$Q_0_{\text{mes}} = 602$  \hspace{1cm} $Q_0_{\text{sim}} = 657$

$\alpha = 0.0042 \text{ dB/mm}$  \hspace{1cm} $\Delta f = 0.2\%$
NARROW BAND MICRO-MACHINED FILTER - 28 GHz

3 POLES

HALF WAVELENGTH RESONATORS

\[ f_{\text{min}} = 27.5 \text{ GHz} \]

\[ \Delta f_{\text{min}} = 500 \text{ MHz} \ (1.8\%) \]

HIGH REJECTION NEEDED (50 dB)

Filter scheme
FILTER MEASUREMENTS
MEASUREMENT RESULTS

VERY GOOD MATCHING (13.5 dB)

FREQUENCY SHIFT (meas/sim) = 0.4%

INSERTION LOSSES = 2.9 dB (1.2 dB\textsubscript{theo} +1 dB line)

HIGH REJECTION (50 dB)

VERIFIED BAND-WIDTH

Si line losses
MEASUREMENT WITHOUT CALIBRATION

HIGH FREQUENCY ISOLATION
FILTER REPORT

FILTER ACCESSES

TARGET: ACCESSES ON THE TOP WAFER TO AVOID TRANSITION
GOOD IMPROVEMENT

SURFACE MOUNTABLE FILTER

CPW ACESSES ON THE TOP OF THE STRUCTURE

FLIP - CHIP REPORT

bump

(1) (2)
Wire bonding or transition to compensate the height of the upper cavity.

EASY REPORT

LOSSES
DETAILS OF THE PROPOSED STRUCTURE

- ground vias
- membrane
- cpw
- slot
- vias
- shielding
- Cpw accesses
- Top level
- slots
- resonator
- Membrane area
TOP WAFER PROCESS

BOTTOM ETCHING 200 µm

VIAS + BOTTOM ETCHING

FABRICATION OF THE UPPER CPW ACCESSES

FABRICATION OF THE SLOTS TO FEED THE FILTER

vias

vias

slot

vias
INPUT / OUTPUT COUPLING

THE FEEDING OF RESONATORS DEPENDS ON THE SLOTS DIMENSIONS

\[ Q_{\text{ext}} = f(\text{slot}) \]

TO INCREASE THE INPUT/OUTPUT COUPLING

INCREASE THE SIZE OF THE SLOTS

H LOOP COUPLES MORE THE RESONATORS
SIMULATIONS/MEASUREMENTS COMPARISON

simulations  $\eta_{\text{ins}} = 0.8\text{dB} \quad f_0 = 30.3 \text{ GHz} \quad \Delta f = 500 \text{ MHz}$

measurements  $\eta_{\text{ins}} = 1.8\text{dB} \quad f_0 = 30.1 \text{ GHz} \quad \Delta f = 450 \text{ MHz}$

GOOD AGREEMENT
CONCLUSIONS / PERSPECTIVES

PRESENTATION OF A NARROW MICRO-MACHINED BAND-PASS FILTER

3 POLES WITH HIGH REJECTION

DESIGN AND FABRICATION OF A SURFACE MOUNTABLE MICRO-MACHINED FILTER

EASILITY OF REPORT

GOOD AGREEMENT SIMULATIONS/MEASUREMENTS

2 POLE FILTER AT 30 GHz

POSSIBILITY TO ACHIEVE COARSER FILTER