THz SIS devices and waveguides

AETHER Sub-Task 4.2 & 4.3 KOSMA: University of Cologne

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THz SIS devices_junctions

- 1.1 THz < f_{RF} < 1.5 THz
- 4.56 mV < h/e . f_{RF} < 6.21 mV
- Practical minimal bias voltage range:
 2.0.5 mV (not usable if incompletely suppressed Shapiro step) + ~ 2.0.3 mV

 \Rightarrow 6.2 mV < V1_{gap} + V2_{gap} < 7.8 mV

At 4.3 K: V_{gap} (Nb)=2.7 mV, V_{BCSgap} (NbTiN) ~ 4.5 mV (Tc=15K), V_{BCSgap} (NbN) ~ 5.0 mV (Tc=16.5K)



THz SIS devices_junction results

- Nb-AIN-NbN : $V1_{gap} + V2_{gap} < 6.2 \text{ mV}$
 - High leakage IV-curve
 - On Si, not on normal conductor for tuning
 - Sum gap less than expected
 - Bad reproducibility
- Tc test samples Nb and NbN too low
 - Sputter machine Vacuum not adequate and worsening => back to leak testing



THz SIS devices_tuning

- f_{RF} > f_{gap}(NbTiN)
- NbN ?
 - High resistivity
 - No good heritage
 - Needs to be epitaxial

⇒Normal conducting tuning

- Calculated coupling
 - < 40%, simple 2 junction tuning</p>
 - E-beam lithography required

KOSMA new E-beam system delivered today



THz Waveguides

Stamped waveguides in CuTe





In house Tooling



4.7 THz waveguide 48 μm x 24 μm









	waveguide		Channel	
	Spec	block	Spec	block
length [µm]	24 +/- 2	23.9	16 + 4 / - 0	17.5
length [µm]	48 +/- 3	49.8	106 + 0 / -5	106
depth [µm]	14 + 1 / - 0	15	5 + 2 / - 1	5



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SEVENTH FRAMEWORK

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Waveguide wall roughness-Issue?



Comparison Measurements with HEBs at 1.9 THz early 2014

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THz Waveguides & Device Assembly

- Devices on thin (2-3µm) Si substrates
 - Assembly plan is part of waveguide design & device design
 - Shifting precision fabrication from workshop to cleanroom (if possible)
 - Blocks as simple as possible
 - > Work Flow (Burrs !)
 - > In house custom tools
 - Small structures by Si etching and subsequent metallization

- Extent the use of beam lead technology



Devices prepared for assembly-before



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SEVENTH FRAMEWOP



Assembly of Devices (5 THz example)





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SEVENTH FRAMEWO

Zoom assembled device





Summary

SIS devices

- Pre-process development 80% done
- Fight sputter machine vacuum
- New E-beam lithography system
- Tuning by normal conducting metals
- THz waveguide blocks
 - Metal waveguides OK
 - Si waveguides---tests early 2014
 - Assembly ! =>
 - Integrate waveguide design and device design
 - Shift precision fab. from workshop to cleanroom