OPTICAL RESPONSE OF STRAINED- AND UNSTRAINED-SILICON COLD-ELECTRON BOLOMETERS

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THE COLD-ELECTRON BOLOMETER

- Direct cooling of electrons in the absorber via superconducting tunnel contacts.

2 devices, unstrained (left) and strained (right). Strain reduces e-ph coupling

<table>
<thead>
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<th>(\Sigma (W \text{ K}^{-6} \text{ m}^{-3}) \times 10^7)</th>
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<tbody>
<tr>
<td>Unstrained</td>
<td>52</td>
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<tr>
<td>Strained</td>
<td>2</td>
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Prest et al., APL 99, 251908 (2011)

Under bias hottest electrons tunnel out of absorber (Sm) and are replaced by cooler carriers from contact. (See G3.12)
CROSS-CORRELATED NOISE REDUCTION

Process flow for cross-correlated noise reduction
RESULTS – ELECTRICAL

\[ I-V \]

Blue – dark data, \( T_{\text{bath}} = 400 \text{ mK} \); black – dark data, \( T_{\text{bath}} = 550 \text{ mK} \); red – optical data, 77-Kelvin source, \( T_{\text{bath}} = 350 \text{ mK} \); green – optical data, 300-Kelvin source, \( T_{\text{bath}} = 350 \text{ mK} \).
RESULTS

Minumum NEP: Unstrained $2 \times 10^{-15}$ WHz$^{-1/2}$, Strained $7 \times 10^{-17}$ WHz$^{-1/2}$
SUMMARY

- Demonstrated cold-electron bolometer using strained and unstrained silicon.
- Used cross-correlated readout to try measure noise below the amplifier’s limit.
- In NEP strained detector outperforms unstrained device by a factor of ~30. Unstrained $2 \times 10^{-15} \text{WHz}^{-1/2}$, Strained $7 \times 10^{-17} \text{WHz}^{-1/2}$.
- In line with reduction in e-ph coupling.

Thanks – Merci – Diolch