

# Supporting Information

## **Tunable Thermal Transport in Polysilsesquioxane (PSQ) Hybrid Crystals**

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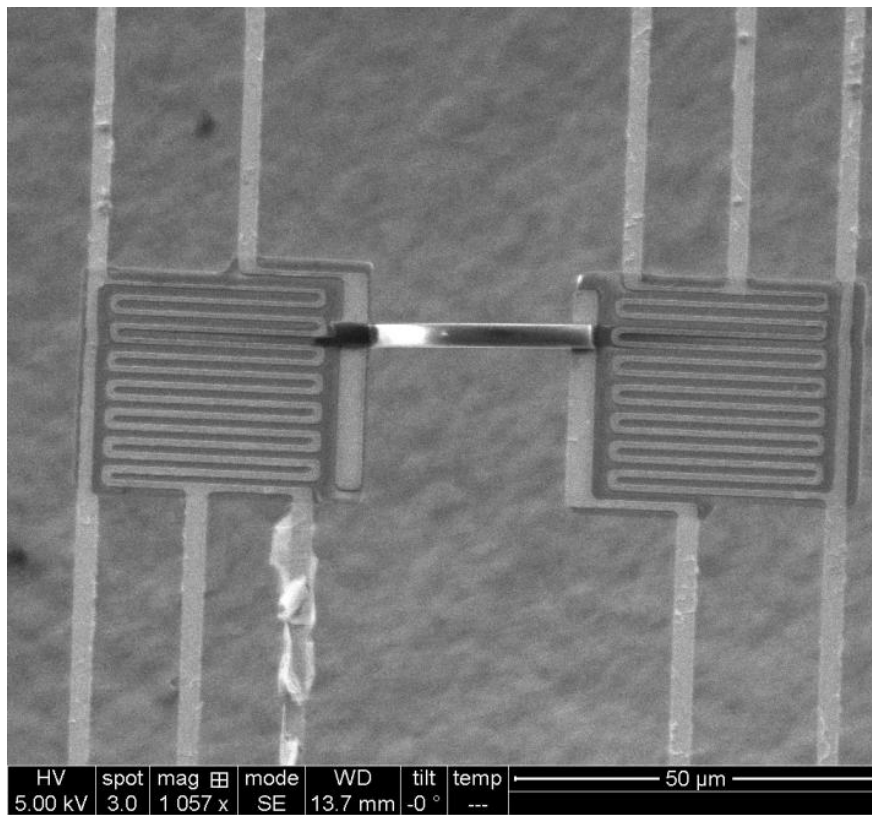
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### 1. SEM characterization of PSQ crystal beams



**Figure S1.** A SEM image of a PSQ beam on the suspended micro device. The brighter region on the PSQ beam is caused by electron accumulation due to intrinsic insulating property of the sample.

### 2. Background heat transfer consideration

As reported elsewhere <sup>1-3</sup>, the background heat transfer between the heating and sensing islands introduces errors and results in an overestimate of the thermal conductance of the PSQ beam. Inspired by previous works, we conduct a control experiment with an empty device

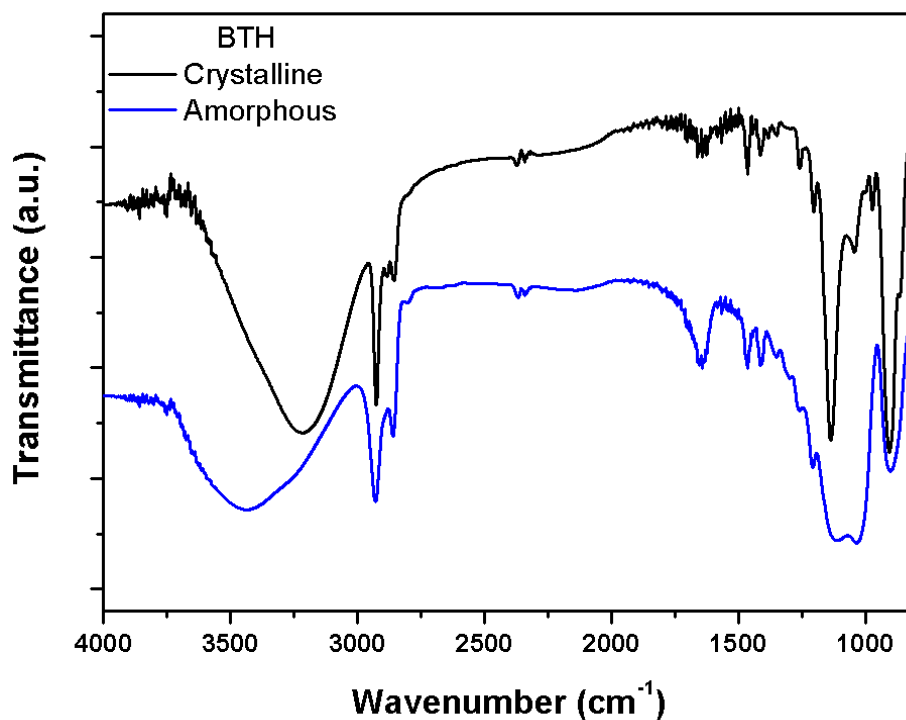
under the same measurement conditions as we measure the PSQ beams. As expected, no noticeable signals are observed from the sensing island. This can be attributed to two reasons:

- 1) The super high vacuum (below  $1 \times 10^{-7}$  Torr) assures an extremely low concentration of residual gas molecules.
- 2) The devices used in these measurements have rather large separation gap between the two islands which is at least  $15 \mu\text{m}$ . As we know the view factor of thermal radiation is inversely proportional to the squared distance between the two objects, therefore, the thermal radiation across the two islands is negligible, especially compared with a typical thermal conductance of  $7.21 \times 10^{-8} \text{ W/K}$  at room temperature. We also consider the heat loss on the PSQ beam due to the thermal radiation to the surrounding. If we ignore the thermal radiation from the surface of the PSQ beam, a relative error below is introduced in the thermal conductivity calculation <sup>1</sup>:

$$\Delta = mL \coth(mL) - 1 \quad (1)$$

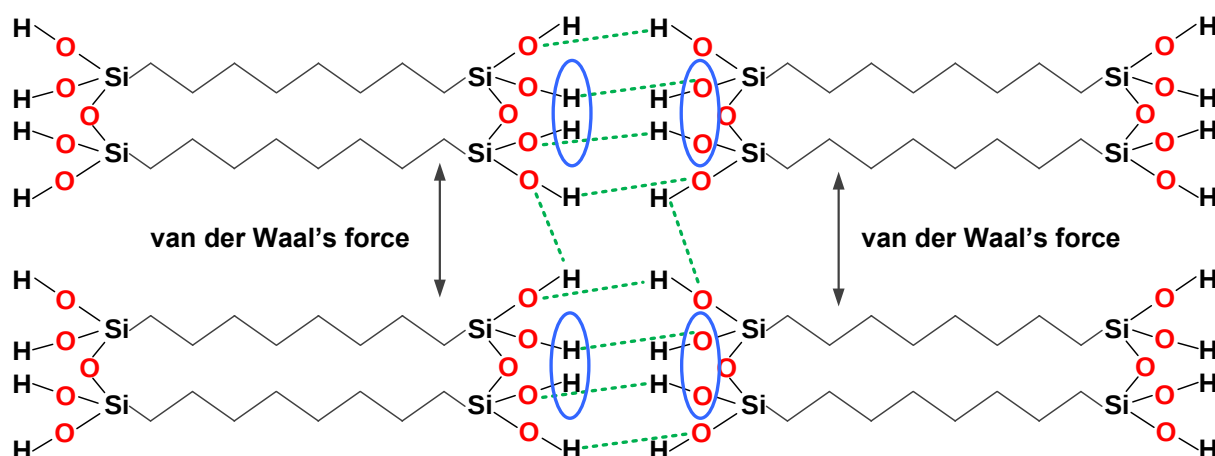
where  $m = \sqrt{8\epsilon\sigma T_{hs}^3(w+t)/(k_s w t)}$ ,  $\epsilon$ ,  $\sigma$ ,  $T_{hs}$  and  $k_s$  are emissivity of the PSQ beam, the Stefan-Boltzmann constant, global temperature, and thermal conductivity of the PSQ beam, and  $w$  and  $t$  are the width and thickness of the PSQ beam. For a typical PSQ beam measure in our experiment,  $w=2.8 \mu\text{m}$ ,  $t=1.04 \mu\text{m}$ ,  $L=16 \mu\text{m}$ , and let  $\epsilon=0.3$ , the relative error  $\Delta$  for ignoring the thermal radiation loss is found to be as small as 0.1%.

### 3. Comparison between crystalline and amorphous C6 samples



**Figure S2.** Fourier transform infrared spectroscopy (FTIR) on a C6 PSQ beam prepared with bis-(trimethoxysilyl) hexane (BTH).

#### 4. A 2D projection of a PSQ crystal structure



**Figure S3.** A 2D projection of a PSQ crystal structure formed by the van der Waals force which binds the sides of the rings and hydrogen bonds which connect the ends of the bimolecular rings. The longitudinal crystal direction is along the carbon chains. The blue circled hydrogen and oxygen are atoms that form hydrogen bonds with molecules in and out paper directions.

## References:

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