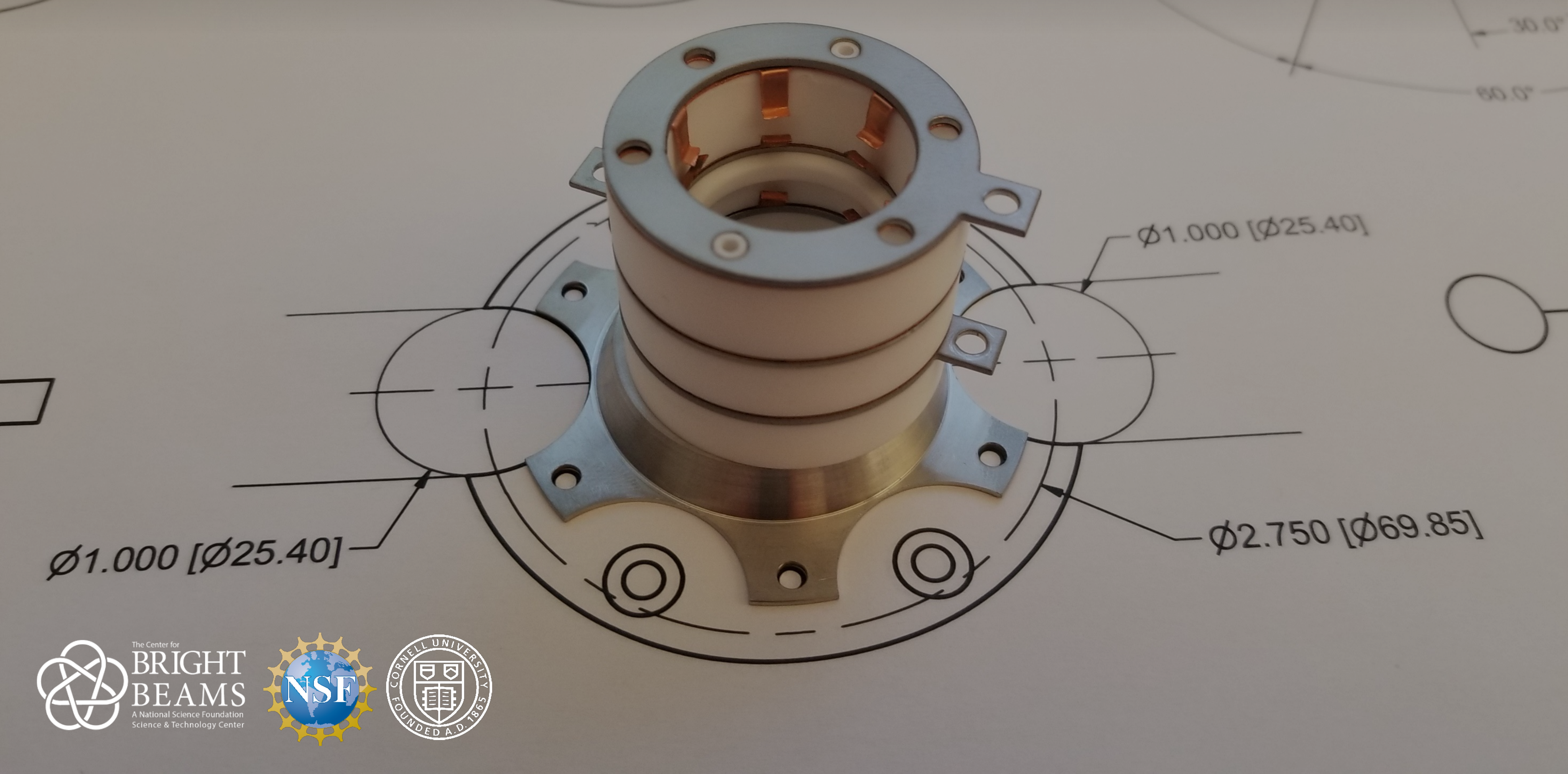
Beam Brightness from Cs–Te Near the Photoemission Threshold

Christopher M. Pierce, Jai Kwan Bae, Alice Galdi, Luca Cultrera, Ivan Bazarov, and Jared Maxson



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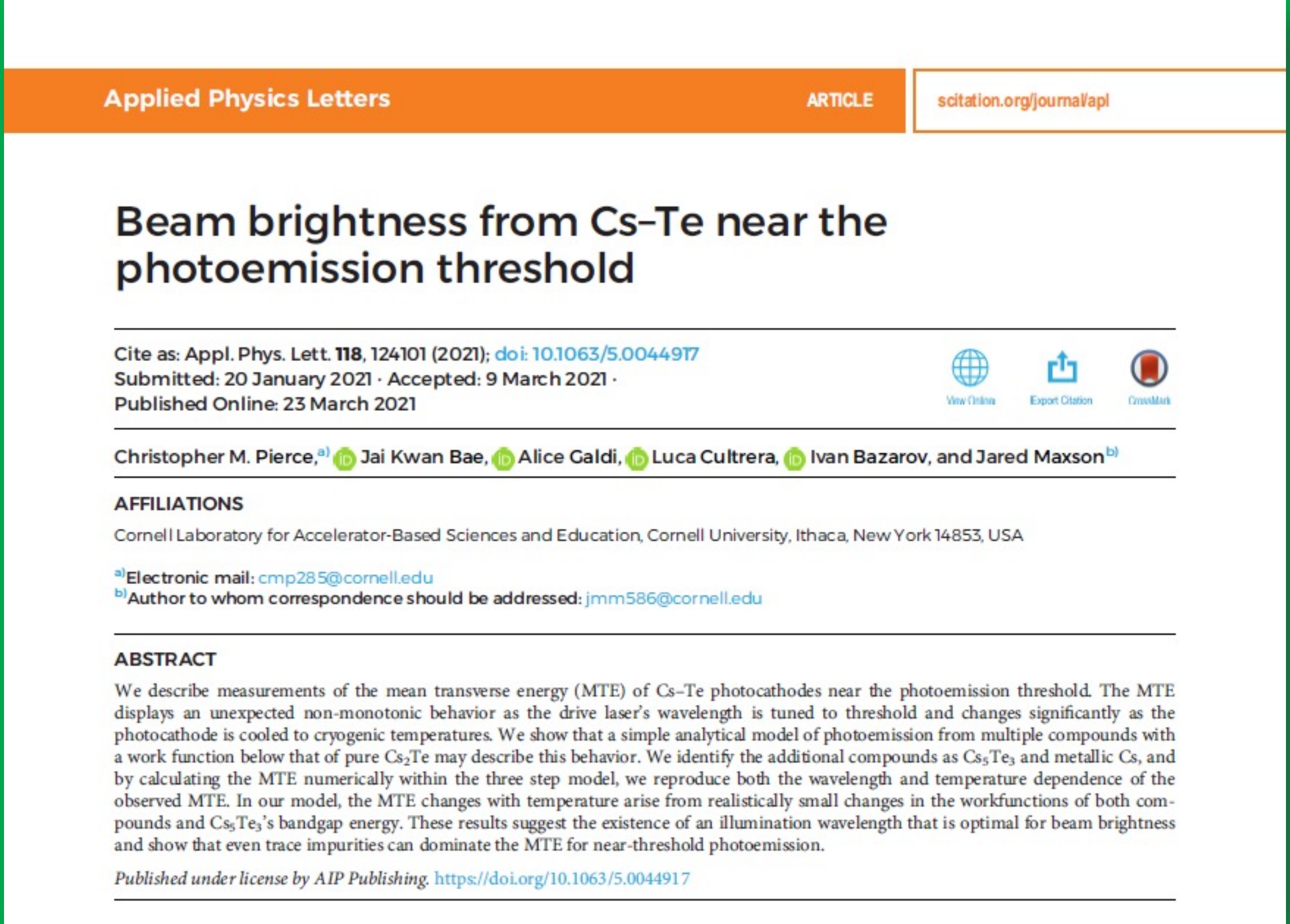
Lack of Near Threshold MTE Measurements in Cs-Te

Let's Explore Gap in Research – Near Threshold MTE of Cs-TE



Applied Physics Letters ARTICLE scitation.org/journal/apl

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Cite as: Appl. Phys. Lett. **118**, 124101 (2021); doi: 10.1063/5.0044917
Submitted: 20 January 2021 · Accepted: 9 March 2021 ·
Published Online: 23 March 2021

View Online Export Citation CrossMark

Christopher M. Pierce,[a] Jai Kwan Bae, Alice Galdi, Luca Cultrera, Ivan Bazarov, and Jared Maxson[b]

AFFILIATIONS

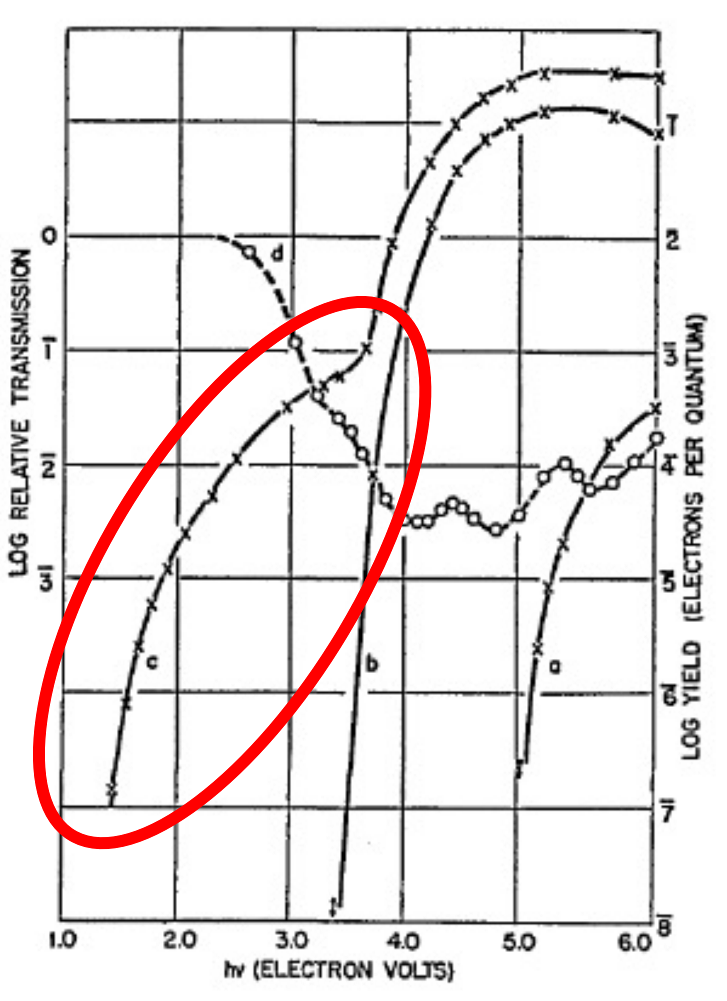
Cornell Laboratory for Accelerator-Based Sciences and Education, Cornell University, Ithaca, New York 14853, USA

[a]Electronic mail: cmp285@cornell.edu
[b]Author to whom correspondence should be addressed: jmm586@cornell.edu

ABSTRACT

We describe measurements of the mean transverse energy (MTE) of Cs–Te photocathodes near the photoemission threshold. The MTE displays an unexpected non-monotonic behavior as the drive laser's wavelength is tuned to threshold and changes significantly as the photocathode is cooled to cryogenic temperatures. We show that a simple analytical model of photoemission from multiple compounds with a work function below that of pure Cs_2Te may describe this behavior. We identify the additional compounds as Cs_5Te_3 and metallic Cs, and by calculating the MTE numerically within the three step model, we reproduce both the wavelength and temperature dependence of the observed MTE. In our model, the MTE changes with temperature arise from realistically small changes in the workfunctions of both compounds and Cs_5Te_3's bandgap energy. These results suggest the existence of an illumination wavelength that is optimal for beam brightness and show that even trace impurities can dominate the MTE for near-threshold photoemission.

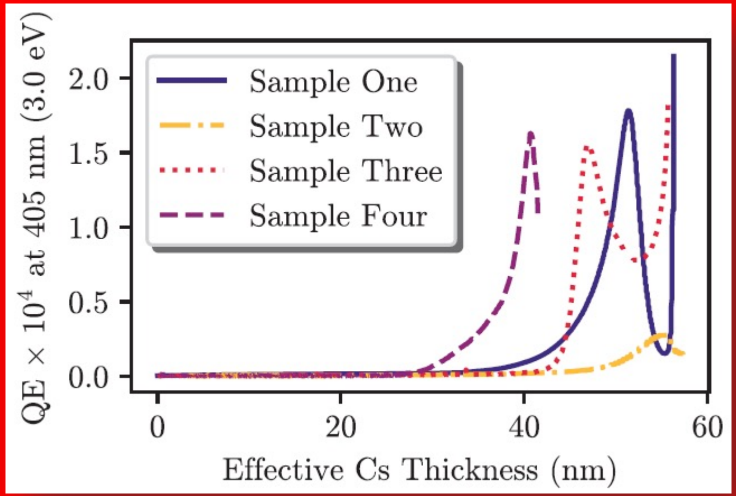
Mystery "Shoulder" in Spectral Response

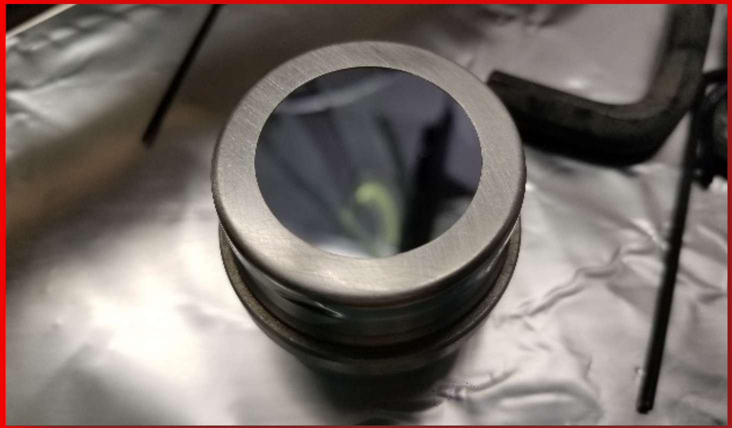


Taft, E., & Apker, L. (1953). *Journal of the Optical Society of America, 43*(2), 81.

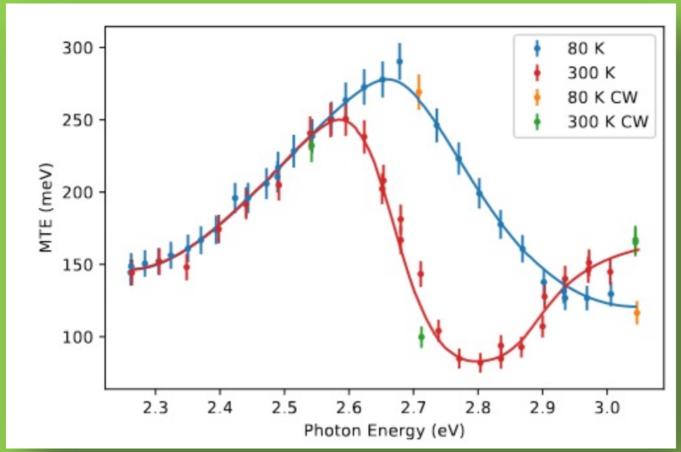
First Measurements Exhibit Strange Non-Monotonicity

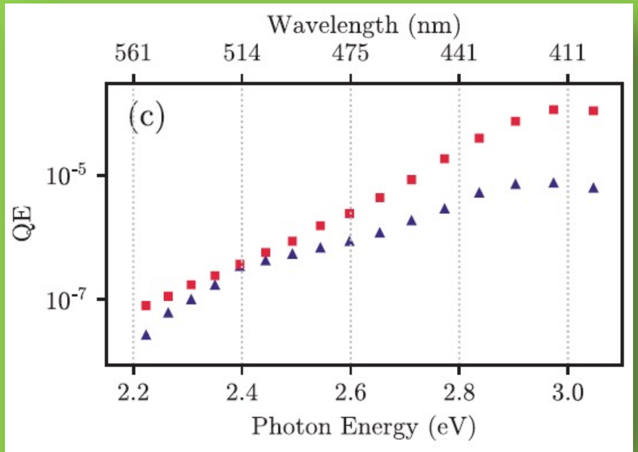
Grow Two Examples of Cathodes w/ Different Cs Content



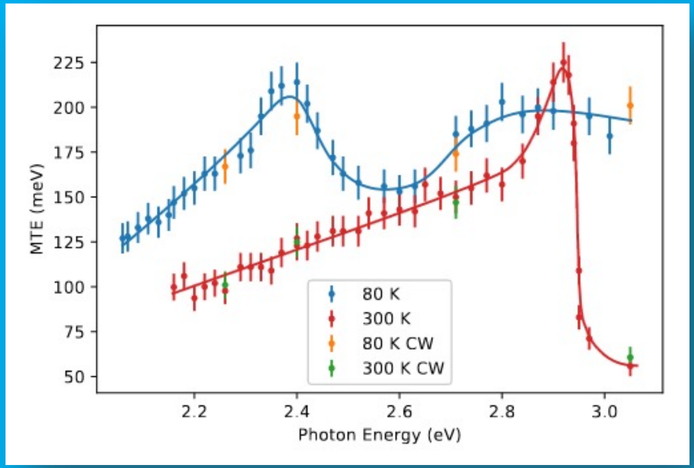


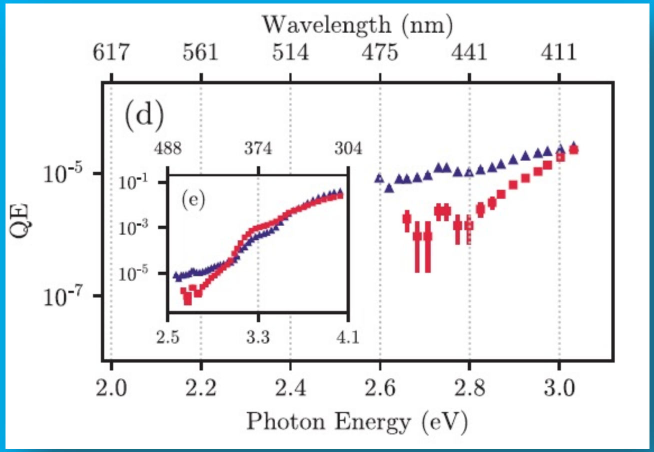
Measurements on "Cs Rich" Growth





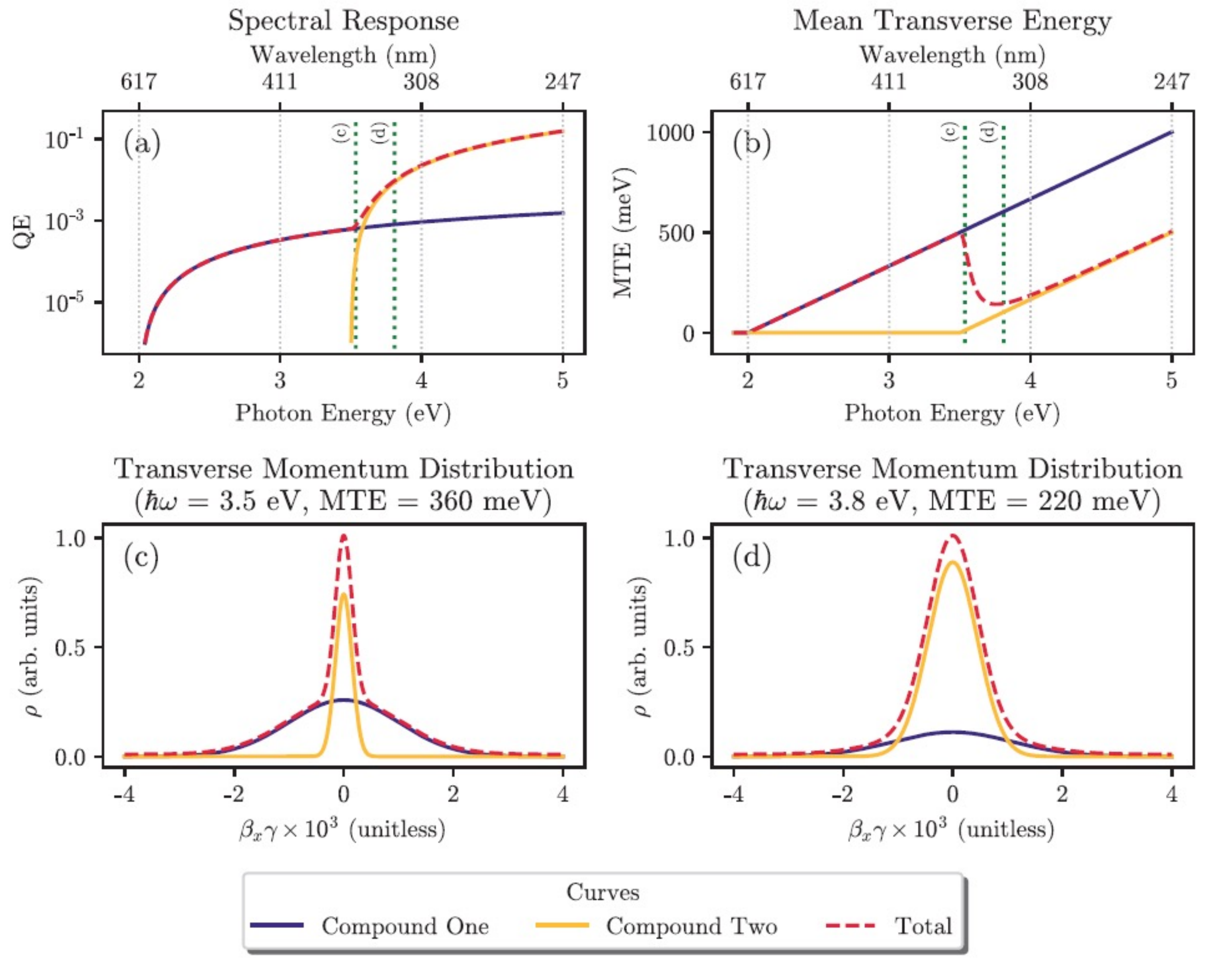
Measurements on "low Cs" Growth



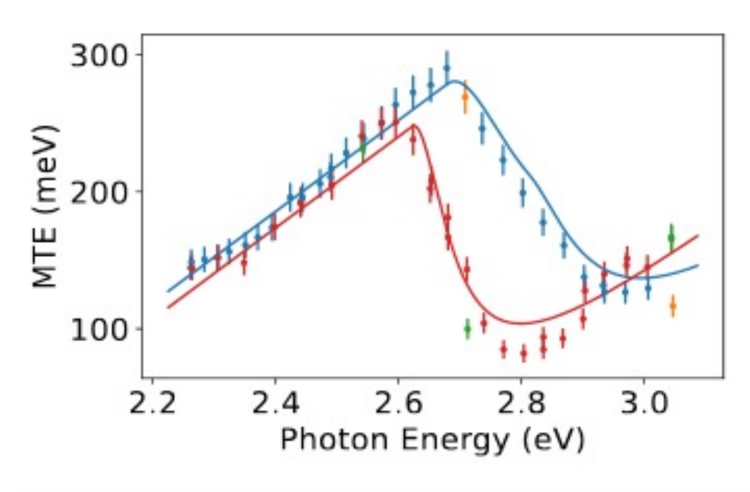


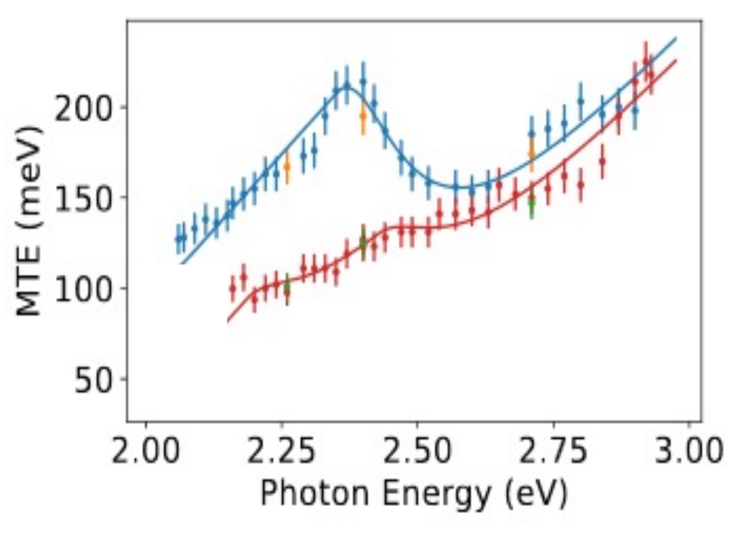
MTE Can be Explained Assuming Composite Cathode

Consider a Model of MTE from a "Composite" Cathode



Using Three Components we can Fit Measured MTE

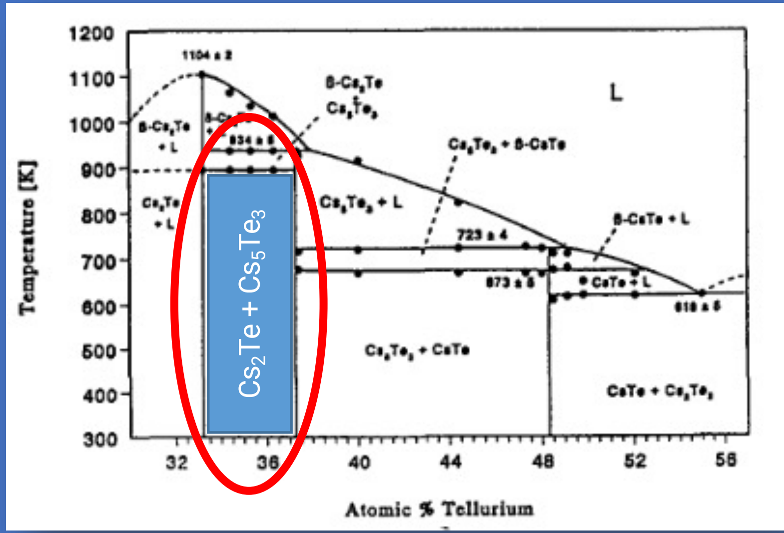




Realistic Materials in Model Recreate Qualitative Features

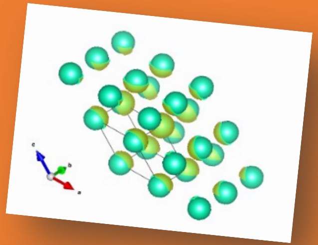
Diffraction Confirms Composite Cathodes

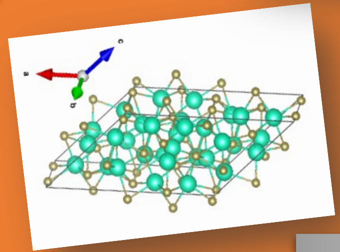
de Boer, R., & Cordfunke, E. H. P. (1995). *Journal of Alloys and Compounds*, 228(1), 75–78.



Consider Numerically Modeling as Cs + Cs_5Te_3

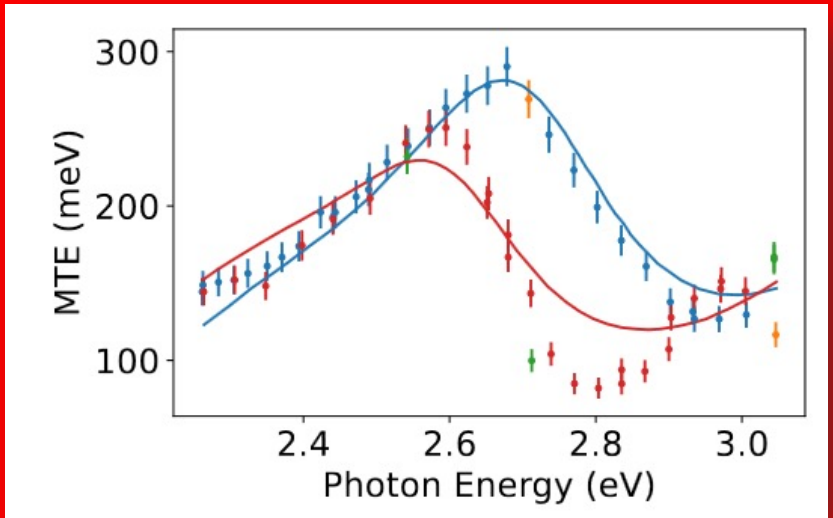
Cs

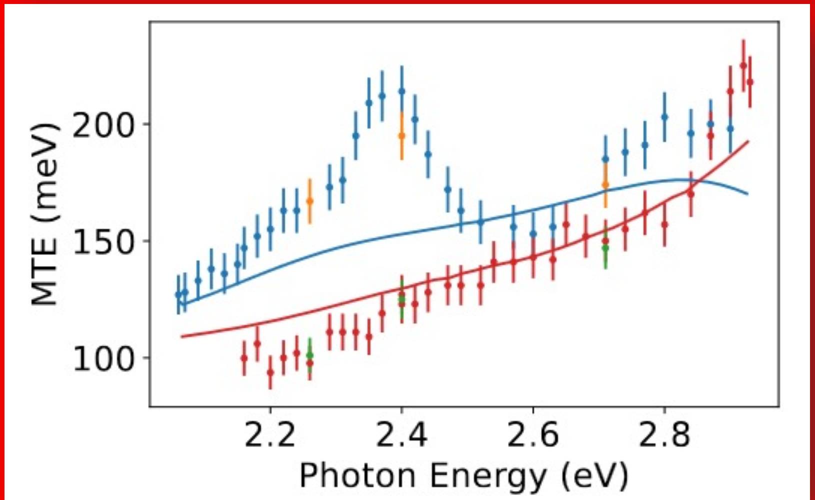




Cs_5Te_3

Calculate Composite MTE and Fit to Data





(For each compound) Find Numerical Bandstructure + Estimate QE/MTE