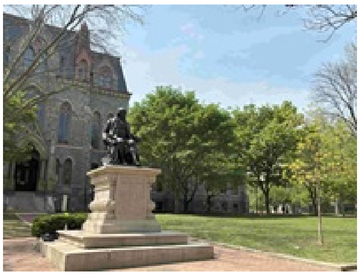

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Superconducting Hafnium films for detectors

Tuesday 7 October 2025 14:15 (15 minutes)

Hafnium (Hf) is a superconducting material that has been gaining popularity among the superconducting detector community –for e.g. TES bolometers (Rotermund et al. in prep), TES calorimeters (Lita et al. 2009, Safonova et al. 2024), optical and near-IR MKIDs (Zobrist et al. 2019, Coiffard et al. 2020), phonon-sensitive MKIDs (Li et al. in prep), STJ (STAR Cryoelectronics SBIR awarded 2022), and QPDs (Ramanathan et al. 2024). Hf is an attractive superconducting film for many reasons, including that its bulk critical temperature (Tc) is near 128 mK, the London penetration depth is estimated to be 20 nm [Kraft et al. 1998], and the surface kinetic inductance is high at around 15-20 pH/□ for a 125 nm film [Coiffard et al. 2020], thus making it well-matched to needs across many experiments.

One key difference between past Hf detector efforts and our own, is our use of a heated sputter deposition. The heated sputter deposition has 2-fold consequences 1) it enables us to precisely tune Tc to our desired target value due to its linear dependence on deposition temperature and 2) it ensures that the Tc is robust against subsequent exposure to heat as long as the initial deposition temperature is not exceeded.

Here we further develope our study of hafnium's material properties that lends itself to being a good superconductor across many detector efforts. We considered film properties such as the phases present through XRD measurements and how they are affected by deposition temperature. XPS measurements reveal the native oxide that grows on the film making it challenging to make good electrical contact with the hafnium. We identify NbN as an alloy that makes reliable electrical contact with high yield.

As an example of a hafnium-based detector, we have successfully fabricated a TES bolometer integrated into a full-stack cosmic microwave background dichroic detector with polarization sensitivity.

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