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Fabrication of Mo/Cu bilayers for TES applications using ion-beam assisted e-beam evaporation

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Superconducting/normal metal bilayers with tunable transition temperature are a critical ingredient to the fabrication of high-performance transition edge-sensors (TES). Popular material choices include Mo/Au and Mo/Cu, which exhibit good environmental stability and provide low resistivity films to achieve adequate Johnson noise levels. The deposition of high quality Mo films requires sufficient adatom mobility, which can be provided by energetic sputter deposition, or by heating the substrate in an e-beam evaporation process. The bilayer TC depends sensitively on the exact deposition conditions of the Mo layer and the superconducting/normal metal interface. Because the individual contributions (strain, crystalline structure, contamination) are difficult to disentangle and control, reproducibility remains a challenge.
Recently, we have demonstrated that low-energy ion-beam assist during e-beam evaporation offers an alternative route to reliably produce high-quality Mo films without the use of substrate heating. The energy and momentum delivered by the ion beam provides an additional control knob to tune film properties such as resistivity and stress. In addition, the surface cleaning effect of the ions substantially affects the bilayer interface. In this report we describe the ion-assist process in detail, including modifications made to the commercial end-Hall ion source to avoid iron contamination of the Mo film.
Electrical and structural characterization results of both single Mo films and Mo/Cu bilayers will be presented.