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Superconducting Coplanar Waveguide Filters for On-chip Spectrometers

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Superconducting millimeter-submillimeter wave resonators can be used as narrow bandpass filters to form a filterbank spectrometer on chip. The resolution of such a spectrometer is primarily set by the quality factor (Q-factor) of the filters. Coplanar-waveguide (CPW) filters have several potential advantages over microstrip filters, for example: (1) ease of making a quarter-wavelength filter, which has its first higher-order harmonic at 3 times the base frequency (as opposed to twice the base frequency for a half-wavelength filter), allowing a wider band coverage of the filterbank, (2) there is no need for depositing dielectrics in the immediate vicinity of the filter, hence minimizing dielectric losses, and (3) the filters can be etched in the same step that forms the ground plane layer of NbTiN/Al hybrid kinetic inductance detectors, thereby adding minimum complexity to the fabrication process. However, at submillimeter frequencies and for CPWs with widths typical for optical lithography, radiation loss hampers the realization of CPW filters with Q-factors in excess of 500, which is the minimum requirement for an astronomical redshift machine. In this study, we have developed NbTiN quarter-wave CPW filters with a total width of 2.4 μm using electron beam lithography. The measured loaded Q-factors have a median value of ~600. This is in close agreement with the designed coupling Q-factor, suggesting that the performance of these filters is not affected by radiation loss, or any other loss mechanism.