Response of Ramp-Type High-T_c Josephson Junctions to Near Millimeter-Wave Radiation

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To explore the potential of using high T_c Josephson junctions as sensitive millimeter- and submillimeter-wave detectors, we have studied the response of a YBCO/PBCO/YBCO ramp-type junction to coherent radiation at 176 GHz and 270 GHz. The I-V characteristic of the junction closely resembles the prediction of the RSJ model. The I_cR_n product of the junction is 0.25 mV at 5K. The millimeter-wave radiation is coupled to the junction via a quasioptical structure which focuses the radiation onto the junction through a yttrium-stabilized ZrO_2 substrate. At 176 GHz, we have observed as many as 6 Shapiro steps at the maximum power level of our Gunn oscillator-pumped frequency doubler. These Shapiro steps are still clearly seen up to 65 K. The widths of the zeroth, first, and the second Shapiro steps as functions of the square root of the radiation power agree remarkably well with a Bessel function fit, indicating the junction is voltage biased at the radiation frequency. At 270 GHz, due to a combination of the heavy RF loss of the ZrO_2 substrate and the lack of radiation power, we have observed only the first Shapiro step.

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