Josephson effects in magnesium diboride based Josephson junctions

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Abstract

We report on Josephson effects in Josephson junctions fabricated from magnesium diboride (MgB_2) thin films using a focused ion beam (FIB) milling technique. The films were deposited on $SrTiO_3(100)$ and $Al_2O_3(1\bar{1}02)$ substrates at room temperature using e-beam evaporation of $MgB_2$with a post-annealing stage in Mg vapour. Conventional photolithography and Ar-ion-beam milling were used to pattern the films into 4 and 8 μm wide microbridges. A focused ion beam was used to narrow the microbridges to 2 μm. The narrowed microbridges were thinned by making 50 nm wide cuts across them. The depth of each cut was calibrated to remove 75% of the film thickness. A thin MgB_2 layer remained on the substrate after this process. The current–voltage (I–V) characteristics of junctions made using this technique show that the junctions carry excess current. The first Shapiro step was observed when one of the junctions was irradiated with a microwave field of frequency f = 8.92 GHz. The Shapiro step appeared at a voltage value $V = hf/2e$ = 18.445 μV.