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Josephson Tunnel-Junctions Fabricated From Epitaxial Niobium-Based Multi-Layers PAUL B. WELANDER, TIM J. MCARDLE, JAMES N. ECKSTEIN, Department of Physics, Frederick Seitz Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801 — We report on the investigation of Josephson tunnel-junctions fabricated from epitaxial multi-layers. The foundation of these devices is the growth of a single-crystal niobium base electrode on sapphire. Niobium films grown near 800 °C typically have critical temperatures around 9.4 K and residual resistance ratios above 100. Diffraction measurements show excellent crystallinity, and microscopy reveals surfaces with mono-layer step-edges and rms roughness less than 0.2 nm. Tunnel barriers are formed using a range of methods. On one hand, epitaxial alumina is grown on niobium above 700 °C by evaporating aluminum metal in an oxygen gas background of about 1 microtorr. On the other hand, an aluminum single- crystal film about 20 nm thick is deposited on niobium at room temperature and then oxidized in 10-100 torr oxygen gas for about one hour. The counter-electrode in both cases is amorphous niobium deposited at ambient temperature. The latter method of barrier formation produces tunnel-junctions with critical current densities around 100 A/cm^2.

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