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Sub-Gap Currents in Nb/Al/AlOx/Nb Josephson Junctions and Their Dependence on the Method of Barrier Formation PAUL B. WELANDER[1], TIM J. MCARDLE, STEPHANIE LAW, JAMES N. ECKSTEIN, Department of Physics and Frederick Seitz Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL 61801 — Josephson tunnel-junctions have been fabricated using two different methods of barrier formation. Both types of devices start with single-crystal Nb/Al bi-layers grown by molecular beam epitaxy on A-plane sapphire. It is found that complete wetting of the Nb layer is achieved with 20 nm of Al evaporated at room temperature. The barrier is then formed either by thermal oxidation of the Al surface in molecular oxygen (the well-known process developed by Gurvitch et al.) or by co-depositing Al in an oxygen background of about 5 micro-torr. A Nb counter-electrode is deposited in situ by evaporation at room temperature. Josephson junctions fabricated from these multi-layers exhibit Fiske resonances and a reduced gap voltage due to the relatively thick Al layer. For devices tested at 4 K, the co-deposition process yields junctions that show a sub-gap current in agreement with theory and no measurable shunt conductance. In contrast, those devices with barriers formed by thermal oxidation show a small shunt conductance in addition to the predicted sub-gap current.

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