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Scanning Tunneling Spectroscopy Studies of AlN Tunnel Barriers Y. LI, Cornell, J. READ, H. TSENG, R. BUHRMAN — Typical Josephson junctions (JJ's) utilize alumina (AlO_x) tunnel barriers due primarily to the reliable thermal oxidation procedure that yield high quality Nb-Al-AlO_x-Nb JJs in the low and moderate ($\leq 10^4$ A/cm^2) critical current density (J_c) regime[1]. However, AlN provides the possibility of forming ultra-thin barriers with fewer defects, and hence lower sub-gap leakage currents, and thus could improve device performance in the high J_c regime [2-4]. We present results from an X-ray photoelectron spectroscopy (XPS) and scanning tunneling spectroscopy (STS) study of thin AlN layers on Nb formed by reactive radio frequency (rf) sputtering from an AlN target in a mixture of Ar and N gases. The XPS spectra indicates that O is generally incorporated into the nitride layer during growth in high and near-ultra-high vacuum, thus forming AlO_xN_y. The STS measurements reveal that these AlO_xN_y layers exhibit an increase in bandgap with increased N content in the process gas. Decreased band-tails and improved surface stability suggest the barrier defect density can be modified through moderate post-growth annealing. We will provide suggestions for optimization of rf sputtered AlO_xN_y layers for use in high J_c Nb and NbN based JJs. [1] Miller, APL 63, 1423 (1993) [2] Wang, APL 64, 2034 (1994) [3] Kleinsasser, IEEE TAS 5, 2318 (1995) [4] Kaul, JMRS 20, 3047 (2005)

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