Process-Structure-Properties of Atomic Layer Deposited Niobium Nitride and Evolution of Strain with Plasma Chemistry

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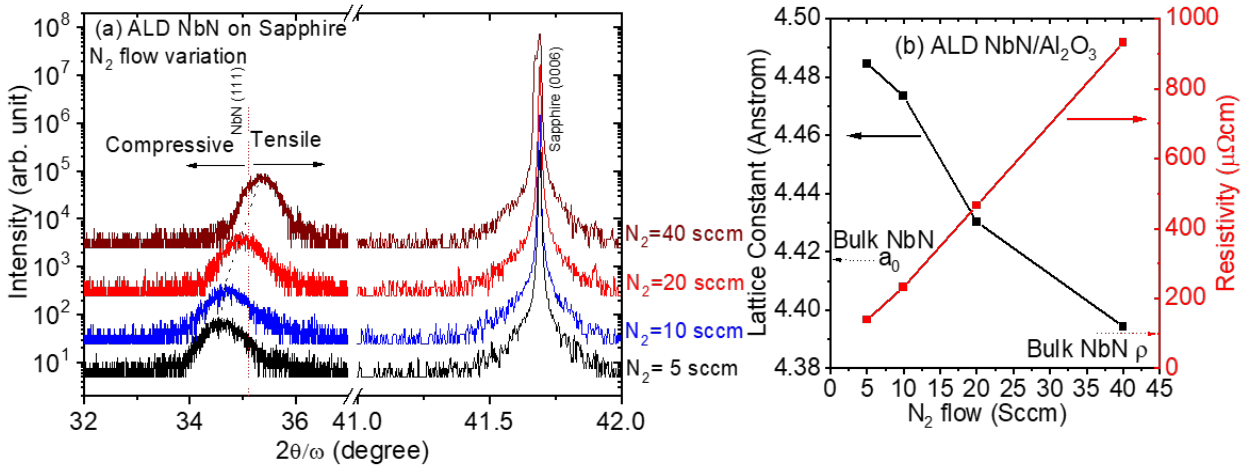

Figure 1. (a) X-ray diffraction scan of PEALD NbN films grown on c-sapphire for the different plasma N_2 flows. Strain changes from compressive to tensile with increasing N_2 flow. (b) Variation of measured lattice constant and room temperature resistivity of the NbN films with the N_2 flow. Film with the lower N_2 flow are compressively strained and has lower room temperature resistivity.

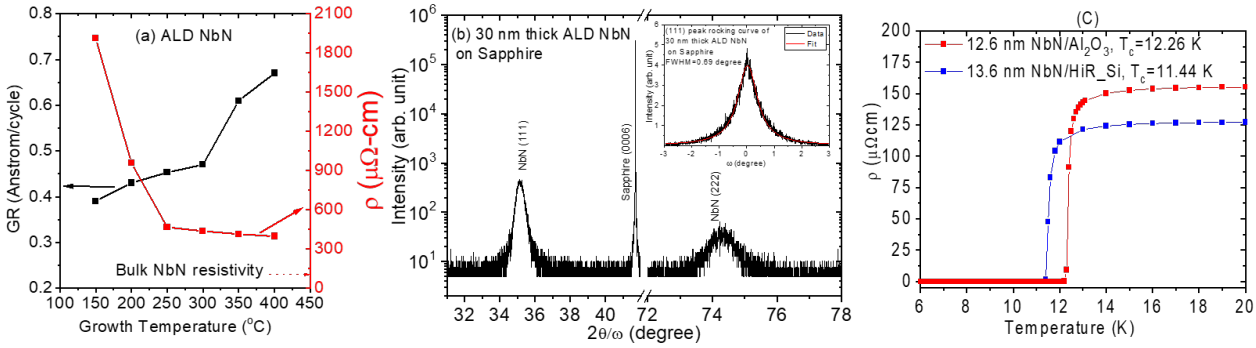

Figure 2. (a) Growth rate and room temperature resistivity of NbN films at different growth temperatures. NbN has an ALD window in the range ~250 to 300 °C. (b) High-resolution x-ray diffraction measurement of 30 nm ALD NbN film on sapphire. 1st and 2nd order XRD peak positions and 0.69° rocking curve FWHM (inset of Fig. 2(b)) show that epitaxial cubic NbN are grown on c-sapphire by ALD. Measured superconducting critical temperature (T_c) of about 13 to 14 nm thick PEALD NbN on Si (blue) and sapphire (red) for N_2/H_2=5/60 sccm. Measured T_c are 11.44 and 12.26 K, respectively.