Nb3Sn Layers on High-Purity Nb Cavities with Very High Quality Factors and Accelerating Gradients, G. MÜLLER, H. PIEL, J. POURYAMOUT, R. RÖTH, CRYOELECTRA; D. MANSEN, Univ. Wuppertal; P. KNEISEL, CEBAF - We have optimized the vapour diffusion technique to coat high-purity Nb cavities up to RRR = 1000 with a micron-thick Nb3Sn layer without loss of the thermal stabilisation of defects. Systematic measurements on samples have shown no change of RRR of the bulk Nb and homogeneously nucleated growth of the Nb3Sn layers. Rinsing of such layers just with high pressure water resulted in low field emission activity and residual surface resistance values in the nΩ range, i. e. comparable to the best Nb surfaces. Single-cell 1.5 Ghz cavities provided Q_0 values up to 10^{11} at 2 K and above 10^{10} at 4.2 K which stayed nearly constant up to peak surface fields of 10 MV/m but decreased to about 10^9 at 20 MV/m. No field emission and no quench could be observed in these cavities up to the maximum achievable accelerating gradients of about 15 MV/m at 2 K as limited by the available rf power. The performance of the Nb3Sn cavities at 4.2 K exceeds the design value of the CEBAF Nb cavities at 2 K. First results on a five-cell cavity are promising.