Broadband Permittivity Measurements of Ruddlesden-Popper Sr\(_{n+1}\)Ti\(_{n}\)O\(_{3n+1}\)(n=1,2,3) Thin Films

N. ORLOFF, W. TIAN, D. SCHLOM, J. BOOTH, I. TAKEUCHI — In order to explore the microwave dielectric response of Sr\(_2\)TiO\(_4\), Sr\(_3\)Ti\(_2\)O\(_7\), and Sr\(_4\)Ti\(_3\)O\(_{10}\) thin films, we have performed broadband in-plane quantitative complex permittivity (\(\varepsilon\)) measurements on Sr\(_{n+1}\)Ti\(_n\)O\(_{3n+1}\)(n=1,2,3) thin films in the frequency range 100Hz-40GHz. The films, of approximately 160 nm thickness, were fabricated by molecular beam epitaxy[1], and standard lithographic techniques were used to define coplanar waveguide transmission lines and interdigitated capacitors using gold. We extracted \(\varepsilon\) from the measured complex S-parameters (.01-40GHz) and the complex impedance (100Hz-.001GHz), which were measured at 70K, 150K, 200K, and 250K using a cryogenic probe station. We found that below \(\sim\)10GHz the \(\varepsilon\)'s of these thin films were approximately constant with frequency: \(\varepsilon \approx 38, 48,\) and 100 for Sr\(_{n+1}\)Ti\(_n\)O\(_{3n+1}\)(n=1,2,3) respectively. In addition, the measured value for \(\varepsilon\) of Sr\(_2\)TiO\(_4\) is consistent with recent theoretical calculations [2]. We will discuss in detail the temperature and electric field dependence of the measured complex \(\varepsilon\) for these material systems. [1] J.H. Haeni, et al APL, 78, 21 (2001) [2] C.J. Fennie and M.K. Rabe, PRB, 68, 184111 (2003)