BiFeO$_3$ is a multiferroic perovskite, i.e., it exhibits both magnetism and ferroelectricity. This unique property makes it attractive for a variety of tunable sensor applications. This nugget summarizes results of epitaxial growth of BiFeO$_3$ films. The key idea is to control the film structure through hetero-epitaxy, leading to unique (and possibly enhanced) physical properties. XRD indicates that the film is phase pure and well oriented. Electron diffraction shows it has tetragonal structure with $c/a=1.02$ (in contrast to bulk, which is rhombohedral). Ferroelectric measurements show a dramatically enhanced polarization value of about 40µC/cm$^2$, which is much higher than reported bulk value of 3-6µC/cm$^2$. Piezoelectric measurements show a $d_{33}$ value of 80-100 pm/V. The films exhibit magnetism with a saturation magnetization of 15-17 emu/cc at room temperature.

![X-ray 0-2θ scan showing that the film is phase pure and (001) oriented. The 4-fold symmetry in the Φ -scan supports a tetragonal structure.](image1)

![Hysteresis loops measured at 10kHz, which shows that the film is ferroelectric with Pr = 40µC/cm$^2$.](image2)

![Small signal $d_{33}$ for a 50µm capacitor.](image3)

![Magnetic hysteresis measured by SQUID. Film saturated at 2000Oe, $M_s$=17emu/cc and $M_r$=2.5emu/cc.](image4)