Insights in High-T_C Superconductivity from the Study of MBE-grown Heterostructures

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We have built a unique molecular beam epitaxy (MBE) system for atomic-layer ('digital') deposition of complex oxides, and developed the technology to synthesize single-crystal films of various oxides (cuprates, nickelates, bismuthates, etc.) with rms surface roughness in the range 0.1-0.5 nm. We have synthesized hundreds of heterostructures (multilayers and superlattices) with atomically perfect interfaces, and fabricated a variety of devices including SIN, SIS, and SNS junctions. These have already enabled some noteworthy insights into the basic physics of high-temperature superconductivity (HTS).[1-3]

In this talk, I will review our most recent experiments (XRD, AFM, TOF-ISARS, HRTEM, transport, resonant X-ray scattering, ultrafast RHEED, etc.) on such films and heterostructures. We have been rewarded with a couple of exciting discoveries. One is *colossal photo-induced expansion* - an unambiguous proof of strong coupling of *in-plane* charge excitations to *out-of-plane* lattice vibrations.[3] Another is *interface superconductivity* with $T_c > 50$ K in bilayers where neither of the two building blocks is superconducting *per se.*[4]

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[1]I. Bozovic *et al.*, *Phys. Rev. Lett.* **89**, 107001 (2002); P. Abbamonte *et al.*, *Science* **297**, 581 (2002)
[2]I. Bozovic *et al.*, *Nature* **421**, 873 (2003); *Phys. Rev. Lett.* **93**, 157002 (2004)
[3]N. Gedik *et al.*, *Science* **316**, 425 (2007); Z. Radovic et al., *Phys. Rev. B* **77**, 092508 (2008).
[4]A. Gozar et al, submitted for publication.