A novel route to realize terahertz-on-a-chip on $Bi_2Sr_2CaCu_2O_8$ cuprate superconductor

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Intrinsic Josephson junctions (IJJ) that occur naturally in the layered high-T_c superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212) enable the propagation of low-loss electromagnetic Josephson plasma waves (JPWs) along the crystalline a-b plane. Excited electromagnetic waves in IIJs can interfere with each other via resonant plasma oscillations, Shapiro steps and Fiske resonances over a wide frequency range from a few hundred GHz to several THz. The versatile IJJ platform can be used to realize a compact THz chip system by integrating a variety of devices such as emitters, high-frequency detectors, waveguides and high-band width receivers based on JPW. While most studies of THz emission from Bi-2212 are based on mesoscopic mesas patterned onto single crystals, a wafer-based system is highly desirable to realize THz-on-a-chip.

In this talk, I will discuss the successful growth of high quality and single-phase superconducting thick films of Bi-2212 on MgO substrates using liquid phase epitaxy (LPE). I will demonstrate LPE growth conditions for improving the size of single phase Bi-2212 grains and their structural and superconducting properties that will enable THz-on-a-chip. In addition, I will discuss a new doping mechanism achieved by high current injection along the c-axis of Bi-2212. This method enables tailoring the properties of IJJs from an insulating to a superconducting state, which may be employed for tuning the functionalities of JPW devices in-situ.