Flexible Superconducting Interconnect Technology for Future Cryogenic Electronics Systems

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The field of superconducting electronics (SCE) has recently seen a significant growth in popularity due to a growing expectation of their use in future cryogenic / quantum / high-performance computing systems. In this talk, I will present our recent efforts on superconducting flexible cables and superconducting cable-to-cable connectors, both of which are needed for dense interconnects and integration in future SCE systems. Rigid or hand-formable co-axial cables used in present systems are bulky and limit the integration density within cryogenic environments due to volume and thermal load constraints. We have developed thin-film, flexible superconducting microwave transmission line cables (with small cross-sections and low thermal leakage) that enable high-performance interconnections within densely-integrated cryogenic electronics systems. These cables and connectors are fabricated using wafer-level, multi-level, thin-film fabrication and laser release processes, primarily with superconducting Nb as the conductor and various types of polyimide as the dielectric. I will discuss the status of our research and development efforts to construct multi-conductor microstrip and stripline superconducting flexible cables and cable-to-cable connectors for use up to 20 GHz and above. A key aspect of our work has been directed at materials (superconductor and dielectric) characterization using superconducting flexible resonators in microstrip and stripline configurations at relevant temperatures (i.e., around 4 K). I will also discuss other challenges, including characterization of superconducting transmission lines with extremely low loss at multiple GHz and at cryogenic temperatures, as well as various reliability characterization activities.