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This research was directed at fabricating mutilayer superconducting tunnel/Josephson junctions for high resolution x-ray detector applications. Substantial progress was made in the growth and characterization of several material systems both as SIS (superconductor/insulator/superconductor) single junctions and SI (superconductor/ insulator) multilayer junctions. SI systems studied included Nb/A ℓ-A ℓO_X, Nb/A ℓN, Nb/A ℓ-A ℓN_X, NbN/A ℓN, Nb/Si, and NbN/SiN. The progress using A ℓN as an insulating barrier is especially significant since this material can be reactively sputtered from an Al target; if the next layer is to be Nb, the N_2 need not be scrupulously purged from the system since small concentrations of N_2 do not significantly suppress T_c (as opposed to O_2 which has a very deliterious effect on T_c of Nb). The I/V characteristics of several single and multilayer Nb/A ℓ-A ℓO_X and Nb/A ℓ-A ℓN_X devices were carefully characterized. Large subgap resistances were obtained in both cases. Shapiro and Fiske steps were studied; in addition Josephson interferance phenomena observed in single and double junctions behaved differently and led to the conclusion that totally new behavior (involving transitions in the vortex lattice) occur in closely coupled multilayer junctions. X-ray counting experiments were performed in collaboration with an NRL group on a multilayer device. The performance was below that of single layer devices fabricated by other labs; however our device was not optomized. Therefore the question remains open as to whether multi junction devices may ultimately out-perform single junction devices.

Based on a proposal by the NRL group that microwave absorbtion might be competitive with tunneling current measurements for x-ray detection, we proposed a novel device in which a Josephson oscillator is loosely coupled to a Fiske cavity. We concluded that monitering changes in the width of the Fiske resonance may be competitive with tunnel current shifts as a strategy to detect x-rays.

The following publications resulted from and cite the NASA supported work:

1. Multilayered Superconducting Tunnel Junctions for Use as High Energy Resolution X-Ray Detectors
E.D. Rippert, S.N. Song, J.B. Ketterson and M.P. Ulmer
Proc. of 1991 Int. Conf. on Optical Applied Science and Engineering EVV, X-Ray and Gamma Ray Instrumentation for Astronomy, SPIE Proc.

2. The Role of Engineered Materials in Superconducting Tunnel Junction X-Ray Detectors - Suppression of Quasiparticle Recombination Losses Via a Phononic Band Gap
E.D. Rippert, J.B. Ketteson, J. Chen, S. Song, S. Lomatch, S.R. Maglic, C. Thomas, M.A. Cheida, M.P. Ulmer Proc. of SPIE 1992 Interionatl Symposoium on Optical Applied Science and Engineering EVV X-Ray and Gamma Ray Instrumentation for Astronomy Vol. 1743, 12 (1992)

3. A Multilayered Approach to Superconducting Tunnel Junction X-ray Detectors
E.D. Rippert, S.N. Song, J.B. Ketterson, S.R. Maglic, S. Lomatch, M.A. Chieda, and M.P. Ulmer
ESA Symp. Proc., ESA sp-356, 361 (1992)

4. Multilayered Josephson Transmission-Line-Based Photon Counting Detector with Ultrahigh Temporal and High Spatial Resolution
E.D. Rippert, S. Lomatch, J.B. Ketterson, S.N. Song, H.C. Wang and S.R.Maglic, J. Low Temp. Phys. 93, 665 (1993)

5. Multilayared Superconducting Tunnel Junction X-Ray Detectors
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6. High Quality a-Si/Nb and NbN/AlN Artificial Multilayers for Josephson Applications
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7. Nonlinear Optical Properties of Metal Nitride Thin Films
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8. Applications for Superconducting Multilayers
J.B. Ketterson, E.D. Rippert, S.N. Song, S. Lomatch, S. Maglic, H.C. Wang, D.J. Morgan and M.P. Ulmer, Proc. 1994 SPIE Meeting in Los Angeles, January (1994)

9. Multilayer Josephson Junction Flux Quantum Devices
S. Lomatch, E.D. Rippert and J.B. Ketterson, IEEE Trans. on Superconductivity 5, 3147 (1995).

10. Soliton Localizaton in a Disordered 1-D Josephson Transmission Lines
S. Lomatch, E.D. Rippert and J.B. Ketterson, Phys. Rev. B 51, 12, 685 (1995)

11. Cavity Modes in Josephson Coupled Superconductor/Insulator Superlattices
S.N. Song and J.B. Ketterson, Physics Letters A208, 150 (1995)

12. X-ray Photon Detection with Multilayered Josephson Junctions
C. Thomas, S.R. Maglic, S.N. Song, M.P. Ulmer, and J.B. Ketterson Nuclear Instrumentation and Methods A370, 38 (1996)

13. Intrinsically Damped Multilayered (Stacked) Nb/Al-AlN/Nb Tunnel Junctions
E.D. Rippert, S.N. Song, C. Thomas, S. Lomatch, S.R. Maglic, M. Ulmer and J.B. Ketterson, Applied Superconductivity 2 (1996)

14. Vortex Structure and Josephson Supercurrents in Stacked Double Josephson Junctions
S.N. Song, P.R. Auvil, M. Ulmer and J.B. Ketterson, Phys. Rev. B53, R6018 (1996)

15. Vortex Structure and Cavity Modes in Stacked Double Nb/AlOX/Nb Josephson Junctions, S.N. Song, S. Maglic, C.D. Thomas, M. Ulmer, and J. B. Ketterson., J. Appl. Phys. 80, 2949 (1996).

16. High Energy-Resolution X-ray Detector Based on a Coupled Fisk Cavity and Josephson Junction Oscillator
S.N. Song, C. Thomas, S. Maglic, M.P. Ulmer and J.B. Ketterson Appld. Phys. Lett. 69, 1631 (1996)