Prototype Superconducting Rectifier is Magnetic-Field-Tunable

(Goddard Space Flight Center) - Superconducting electronic components have been developed that provide current rectification that is tunable by design and with an externally applied magnetic field to the circuit component. The superconducting material used in the device is relatively free of pinning sites with its critical current determined by a geometric energy barrier to vortex entry.

The ability of the vortices to move freely inside the device means this innovation does not suffer from magnetic hysteresis effects changing the state of the superconductor. The invention requires a superconductor geometry with opposite edges along the direction of current flow. In order for the critical current asymmetry effect to occur, the device must have different vortex nucleation conditions at opposite edges.

Alternative embodiments producing the necessary conditions include edges being held at different temperatures, at different local magnetic fields, with different current-injection geometries, and structural differences between opposite edges causing changes in the size of the geometric energy barrier. An edge fabricated with indentations of the order of the coherence length will significantly lower the geometric energy barrier to vortex entry, meaning vortex passage across the device at lower currents causing resistive dissipation.

The existing prototype is a two-terminal device consisting of a thin-film superconducting strip operating at a temperature below its superconducting transition temperature (Tc). Opposite ends of the strip are connected to electrical leads made of a higher Tc superconductor. The thin-film lithographic process provides an easy means to alter edge-structures, current-injection geo - metries, and magnetic-field conditions at the edges. The edge-field conditions can be altered by using local field(s) generated from dedicated higher Tc leads or even using the device’s own higher Tc superconducting leads.