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Infrared Nanoantenna-Coupled Rectenna for Energy Harvesting

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Energy harvesting from relatively low-temperature heat sources is important in applications where long-term power sources are needed. Current solutions are low efficiency and require exotic materials and structures. While the infrared rectenna is currently low efficiency, the path exists for high-efficiency solid state devices. We have made a scalable design using standard CMOS processes. This would allow devices to be made on the wafer scale using existing fabrication technology. The rectenna has the advantage of using radiated power, thus it does not require direct contact to the hot source, but instead must only view the source. This will simplify packaging requirements.

Here we will discuss the physics of operation, particularly light coupling into the structure. Incoming light is coupled to a metal-oxide-semiconductor (MOS) tunnel diode via a large-area nanoantenna. The nanoantenna consists of a subwavelength metal patterning that concentrates the light into a tunnel diode where the optical signal is rectified. Both the nanoantenna and tunnel diode are distributed devices, utilizing the entire area of the surface. The nanoantenna also serves as one contact of the tunnel diode. This direct contact of nanoantenna and diode region overcomes the resistive losses of leads found in prior IR rectenna concepts.

We will show simulation and experimental results of fabricated devices. Simulations of the optical fields in the tunnel gap are illustrative of device operation and will be discussed. The measured infrared photocurrent is obtained as a function of the source temperature, sample distance and view factor. Far-field radiation power conversion is examined using standard radiometric techniques and correlated with the rectified current response.

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