Multi-Mode Energy Scavenging From the Environment

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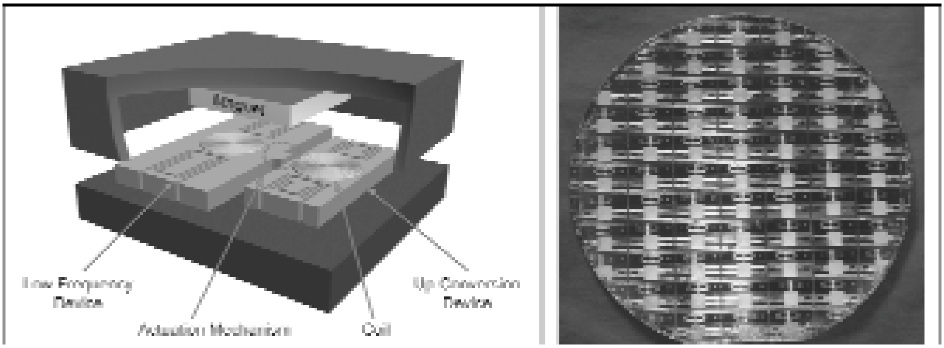

Left – A conceptual illustration of the electromagnetic generator, Right – Wafer-level photograph of the fabricated devices.

Power generation plays a critical role in remote-controlled sensor network nodes for environmental monitoring. The required power for these systems can be generated mainly in two ways: by using electrochemical batteries and microfuel cells, and by scavenging energy from the environment. Currently, the project's focus is on extracting energy from vibration. Environmental vibration is a particularly attractive energy source because of its abundance. However, the maximum generated electrical power from a vibrating mass is strongly dependent on the external vibration frequency, and drops dramatically at low frequencies (1Hz–10Hz). But it is at these low frequencies where most ambient vibration exists. This project is developing a vibration-to-electrical power generator, which scavenges energy from low-frequency external vibrations by mechanically up-converting them to a higher frequency. Energy is coupled from the environment to a low-frequency, sensitive resonator, which then passes a portion of this energy to a second resonant element which is used for conversion to electrical energy, operating at a higher frequency. Simulations show a 37% improvement in energy density when using frequency up-conversion over other approaches. The device is designed to operate at 100Hz, giving a power density of $10mW/cm^3$. This project is supported primarily by the Engineering Research Centers Program of the National Science Foundation under award number EEC-9986866.