Printed Microinductors for Flexible Substrates

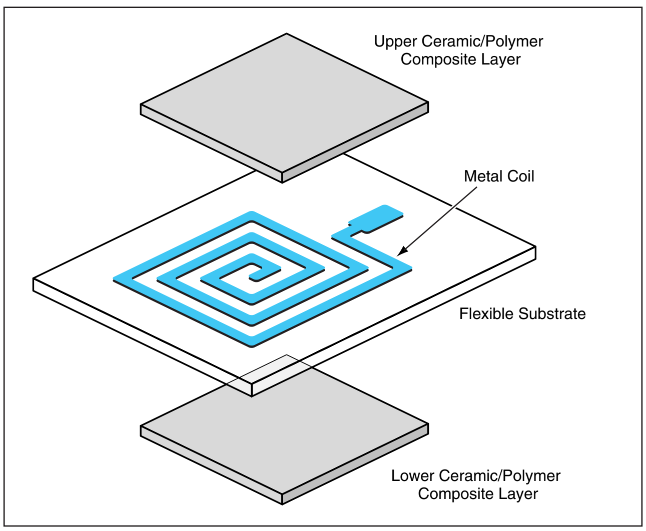
Magnetic composite layers are combined with hermetic coatings to optimize electrical and mechanical properties.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method of fabricating planar, flexible microinductors that exhibit a relatively high quality factor (*Q*) between 1 and 10 MHz has been devised. These inductors are targeted for use in flexible, low-profile power-converter circuits. They could also be incorporated into electronic circuits integrated into flexible structures, including flexible antenna and solar-sail structures that are deployable.

Fabrication of inductors on flexible, heat-sensitive substrates is typically limited by the need for high-temperature annealing step of the magnetic material. Highly loaded ceramic/polymer composite films can be seen printed and cured at lower temperatures, but suffer poor adhesion. Thus, a new approach is required to enable the fabrication of high *Q* inductors (for power applications) on the flex substrates.

The microinductor comprises a planar spiral metal coil and a high-permeability magnetic thick-film (equivalent to the core of a conventional inductor) in the form of a ceramic/polymer composite. The metal spiral is fabricated by photolithography and etching of a copper-clad flexible polyamide substrate. The ceramic/polymer composite is deposited by stencil and screen printing, both above and below the metal spiral (see figure).



A **Flexible Inductor of Three Layers** is fabricated as an integral unit by thick-film processing techniques.

To obtain sufficient permeance and volume magnetization for the required degree of enhancement of inductance, the mass fraction of the ceramic in the ceramic/polymer composite must be about 95 percent, which is greater than the mass fractions of fillers typically incorporated into polymer-matrix thick films. In general, such a high mass fraction of filler can adversely affect printability and adhesion and can make the printed thick films susceptible to mechanical failure and delamination during flexure. These adverse effects can be overcome, to a degree that makes it possible to produce an inductor of both acceptably high *Q* and acceptable mechanical properties, by (1) proper choice of the polymer resin and the ceramic magnetic powder filler for the thick-film formulation, in conjunction with (2) the use of a hermetic-coating technique.

Of the resins tested, polyester resins demonstrated the best loading and adhesion characteristics. A magnetic powder comprising Mn-Zn ferrite particles about 10 μm in diameter was found to yield good magnetic properties. It was found that improved adhesion could be obtained through coating with vacuum-polymerized parylene.

This work was done by Erik Brandon, Jay Whitacre, and Emily Wesseling of Caltech for **NASA's Jet Propulsion Laboratory.** *Further information is contained in a TSP (see page 1).*

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Series-Connected Buck Boost Regulators

Sizes and power losses are smaller than those of conventional switching voltage regulators.

John H. Glenn Research Center, Cleveland, Ohio

A series-connected buck boost regulator (SCBBR) is an electronic circuit that bucks a power-supply voltage to a lower regulated value or boosts it to a higher regulated value. The concept of the SCBBR is a generalization of the concept of the SCBR, which was reported in "Series-Connected Boost Regulators" (LEW-15918), *NASA Tech Briefs*, Vol. 23, No. 7 (July 1997), page 42. Relative to prior DC-voltage-regulator concepts, the SCBBR concept can yield significant reductions in weight and increases in power-conversion efficiency in many applications in which input/output voltage ratios are relatively small and isolation is not required, as solar-array regulation or battery charging with DC-bus regulation.