HIGH FREQUENCY NEAR-FIELD IMAGING OF MICROWAVES WITH CALORIMETRIC CANTILEVER PROBES

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The development of techniques for measuring high-frequency near-field microwaves is motivated by potential applications that include the detection of interference, short circuits, or coupling of on-chip components. Existing magnetic field measurement probes use a wire loop to measure the induced voltage or current across the wire loop [1]-[3]. The spatial resolution of these systems is limited by the magnetic flux passing through the loop and is thus limited by the area of the loop. The spatial resolution is typically on the order of one millimeter to tens of micrometers [1]-[3]. Furthermore, the RF frequencies that the system can measure is limited by the RL time constant (resistance and inductance) of the wire, and are typically in the megahertz or low-gigahertz range.

In this paper, a new type of multi-material, MEMS-based cantilever probes were developed for high frequency (1-20 GHz) magnetic field imaging. The basic configuration of the probe consists of a cantilever beam fabricated by surface micromachining and bulk micromachining techniques with dielectric silicon nitride and silicon oxide materials, on a silicon wafer. A gold patterned metallization at the tip of the cantilever provides a source of eddy current heating due to the perpendicular component of the high frequency magnetic field. This thermally-absorbed power is converted to mechanical deflection by a multi-materials trilayer cantilever system. The deflection is measured with a beam-bounce optical technique employed in AFM systems. Experimental characterization of the MEMS probes is performed with different applied RF Power and location to the RF source to study the field sensitivity. The size of the patterned metallization is determined to yield different spatial resolution of the system. Analytical models and finite element modeling is performed to guide the design of the MEMS probes to yield the appropriate sensitivity. The analysis and experiment show that an asymmetrical tri-layered (nitride-oxide-nitride) structure is a better approach than a bimorph structure because it reduces the curvature associated with the thermal misfit strain developed during high temperature deposition. The fabrication of these multi-materials trilayer probes is also discussed.

References

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