Soft Magnetic Materials and Devices on Energy Applications

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1 Abstract

The fast development of wireless communication system in recent years has been driving the development of the power devices from different aspects, especially the miniaturized volume and renewable power supply, and etc. In this work, we studied the high frequency magnetic properties of the soft magnetic material -- FeCoB/Al_2O_3/FeCoB structures with varied Al_2O_3 thickness (2nm to 15nm), which would be applied in to the integrated inductors. Optimized Al_2O_3 thickness was found to achieve low coercive field and high permeability while maintaining high saturation field and low magnetic loss. Three types of on Si integrated solenoid inductors employing the FeCoB/Al_2O_3 multilayer structure were designed with the same area but different core configurations. A maximum inductance of 60 nH was achieved on a two-sided core inductor. The magnetic core was able to increase the inductance by a factor of 3.6 ~6.7, compared with the air core structures.

Vibration energy harvesting technologies have been utilized to serve as the renewable power supply for the wireless sensors. In this work, two generations of vibration energy harvesting devices based on high permeability magnetic material were designed and tested. The strong magnetic coupling between the magnetic material and the bias magnetic field leads to magnetic flux reversal and maximized flux change in the magnetic material during vibration. An output power of 74mW and a working bandwidth of 10Hz were obtained at an acceleration of 0.57g (g=9.8m/s^2) for the 1st generation design, at 54Hz. An output voltage of 2.52 V and a power density of 20.84 mW/cm^3 were

demonstrated by the 2nd generation design at 42 Hz, with a half peak working bandwidth of 6 Hz.

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