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Depletion and Harvesting Thermal Energy from Actuator Arm Electronics in Hard Disk Drives

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Abstract

In recent years, thermally assistive magnetic recording (TAMR) has been applied on actuator arm electronics (AE) in hard disk drive (HDD). When HDD operates, temperature of the AE chip inside enclosure can be as high as 80-100 ºC, primary caused by processing and conditioning of magnetic signals and heated by wasted mechanical energy in form of thermal energy. To guarantee reliability of electronic device, AE chip junction temperature should be maintained at a relatively low level, which requires novel depletion of thermal energy. There are generally two methods to manage the thermal dissipation of chips. One is to follow existing approaches that conduct the thermal energy from the topside of the chip to a heat sink through a conductive paste, or other mediums. The other way is to dissipate the heat from the inner surface of the chip to a heat sink through silicon substrate.

In this thesis, thermal analysis of AE chip junction temperature is presented and discussed. Depletion of thermal energy generated by the AE chip will be characterized among several thermal management configurations. Then, a thermal resistance network model is established for AE chip junction temperature to ambient. The thermal resistance network is based on heat transfer paths from the chip to ambient. Every thermal resistance in the network can be calculated by analytical expression. The accuracy of the presented model will be also proven through comparing the results of mathematic model and simulation. Finally, based on the thermal analysis and managements, design of a novel active thermal energy harvester to transform the wasted energy into electrical energy will be presented. Finite element analysis (FEA) software is used to simulate piezoelectric characteristics of the thermal energy harvester.

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