Three Dimensional Model for Microscale Cathodic Protection

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ABSTRACT

Corrosion reactions can occur on any metal surface regardless of its size. For small-scale systems, e.g. corrosion reactions on the giant magneto resistive (GMR) element in the reader part of the hard disk drive can be detrimental and yield device failure either during manufacturing or in service. In magnetic hard disk industry, the spacing between the reading head and the magnetic substrate is as small (approaching zero) as possible to increase the areal density of the magnetic disk. This leads to reduction in the thickness of the diamond like carbon protective layer. This layer main purpose is to protect the surface from corrosion and mechanical damage of the reading head. In such systems, even very small corrosion rates cannot be tolerated and selected manufacturing processes have to be applied. In a recent study [1], a cathodic protection system was suggested to reduce the corrosion current in small scale structure via implanting or deposition an active anode next to the metal structure to be protected. Also, the model was built to simulate cathodic protection of small-scale systems on a two dimensional level. The model was solved using finite element method for current and potential distribution.

In the present study, similar analysis was extended to a three dimensional level to simulate the real geometry of the reader. A new three-dimensional model will be presented in this work to solve the secondary current distribution between two microelectrodes. Current and potential distribution will be presented as function of the geometry and electrolyte parameters. In this model, finite element technique was used to solve the Laplace equation in the electrolyte and the solution domain had two embedded electrodes in an insulating surface. On of the main results to be presented is the effect of distance and shape of the anode on the level of cathodic protection current. Such results are important in the design stage of the reader to implement the proper size and shape of the anode.

References:

1. M. Alodan, “Modeling of Microscale Galvanic Reaction for Cathode Protection”, ECS proceedings, ECS conference in San Francisco. Fall 2001.