Design and Fabrication of Magnetic Nanowire Array Thin Films for High-energy Photon Portal Imaging

Richard Makori Ongeri

A thesis submitted in fulfillment for the Degree of Doctor of Philosophy in Physics

in the Jomo Kenyatta University of Agriculture and Technology.

2009

ABSTRACT

Ni-Fe magnetic nanowire array thin films that may be used to realize a magnetic portal imaging device were electrodeposited in the pores of anodic aluminium oxide (AAO) membranes. The membranes were first fabricated by a two-step process by anodizing 0.47 mm thick commercial aluminium foil in 0.50M sulphuric acid under constant dc potentials between 11V and 29V. The evolution current during the anodizing and electrodeposition processes were recorded using a data logger. The surfaces of the AAO films were studied at different stages of evolution of the nanopores and after electrodeposition of the Fe-Ni nanowires, using optical and electron microscopy. Results indicate that a barrier aluminium oxide thin film first formed on the aluminium surface prior to the formation of AAO membranes. The time for the formation of the barrier oxide decreased with increasing anodizing voltage, but was less than 40 seconds for AAO films synthesized at 15 V dc. It was also observed that 0.5 M sulphuric acid produced an organized nanopore pattern only after the second step anodizing process. It was noted that the amount of grey colour and pore diameter of AAO films increased with anodizing voltage, and low anodizing voltage and high temperature produced more surface defects. Current curves indicated that anodizing current, and hence rate of pore formation, decreased with temperature but increased with voltage. It was observed that electrodeposition of nanowires in AAO membranes took place in three stages, corresponding to deposition at the pore bottom, pore length and deposition outside the pores. In our study, the first nanopore was filled in approximately 710 s.