DESIGN, CONSTRUCTION AND TESTS OF A NEW ELECTROPLATING REACTOR FOR MAGNETIC MATERIALS DEPOSIT

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Introduction

In all micro-system applications, and especially for magnetic devices, electroplating step becomes more and more strategic. Actually, there are many advantages to use ECD instead of PVD or CVD, in a cost, layer thickness and versatility point of view [1]. Nevertheless, the main drawback of ECD technology for magnetic materials is the non-uniformity of deposit thickness and alloy composition between the center and the edge of a silicon wafer. In order to improve this uniformity, a new reactor has been developed. First of all, electrochemical modeling has been achieved [2], in order to optimize the reactor geometry. We have taken into account that this reactor had to be designed for magnetic materials, and a permanent magnet has been integrated around the cathode. For this reason, the rotation of the wafer was impossible and the reactor design has been defined with a steady cathode. Then, a DOE has been done to optimize the fluid flows conditions along the cathode and finally, the reactor has been built.

Modelling

Electrochemical simulations have been achieved with ELSY 3 and MIoTraS software which have been supplied by ELSYCA in the framework of an EC project. The reactor geometry has been defined and optimized with ELSY (fig.1) and the fluid flows conditions have been determined with MIoTraS and confirmed by TRIO-U, a software from CEA nuclear department. So, the reactor has been built from these simulations results.

Construction

The main part of the reactor make up by a regular cone which has been cut in a lot of parts. The cathode holder is always the last part of the regular cone and a rack system allows to block the cone in process position. Each part of the cone can be an anode receiver. This system allows to modify the anode cathode distance, the anode size and to use many anodes very simply. It also allows to create a diaphragm effect with a variable diameter at the cone outlet. Thanks to this great flexibility, this reactor can be adapted to a lot of different processes, even for non-magnetic materials.

Experimental results

The first experimental results have been obtained for CoFe alloy (Fig. 2). This alloy has been chosen because it's more simple to study than ternary alloys like CoFeCr or CoFeNi. Nevertheless, the electrochemical behaviours of these materials are very similar and the optimized parameters for CoFe are also usable for other CoFe family alloys [3]. The deposit uniformity is very promising in the new reactor : 2 % (1σ) on a 76 mm diameter and for a full layer deposit (Fig.3). In the same conditions in our former reactor, we only had 18 % (1σ). The deposit velocity (0.1 µm/min) and the alloy composition uniformity (3 % (1σ)) are comparable to the former reactor. These results will be probably improved in a very near future, thanks to modifications on the cathode holder electrical contacts and geometric parameters optimization by modeling.

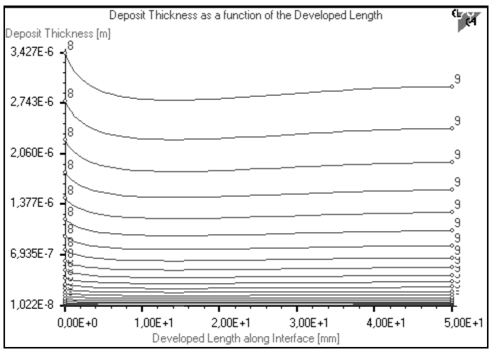

Figure 1 : Deposit thickness along the cathode obtained by electrochemical modelling with ELSY 3

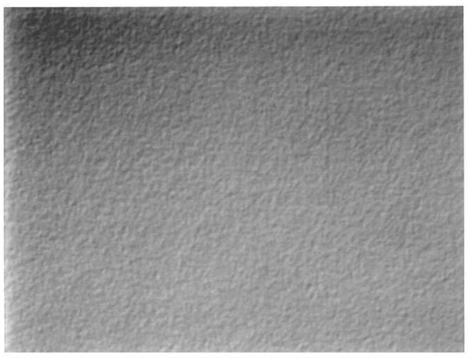

Figure 2 : CoFe layer granulometry after electroplating in the new reactor (x50)

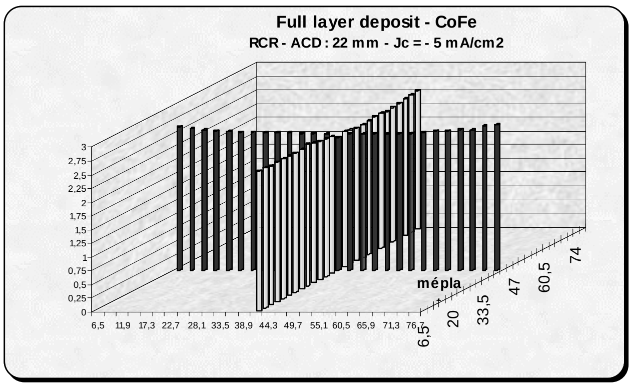

Figure 3 : Deposit cartography on Silicon wafer (76 mm diameter) for CoFe alloy. Thickness : 2.2 µm at 2% (1σ). Mechanical profilometer measurements.

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