Future Prospective on Electroless Plating
– Some Applications in the Electronics Field –

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Electroless plating is first demonstrated by Brenner and Riddel in 1946 [1], and most advantageous point of this method is to form the metal films on non-conductive substrate as compared with that of electroplating. Moreover, the electroless plating method does not suffer from the problem, current distribution, hence it should be more suitable for depositing uniform films on substrates with fine and complex geometries. Recently, some high performance films have been obtained only using electroless plating. There is a possibility for an electroless plating process to play an important role in the field of electronics industry due to its various advantages. Near future, micro- and nano- devices may be realized using electroless plating. In this paper, some applications of electroless plating methods in the electronics field were overviewed on the basis of this points.

Electroless Ni and Ni alloy films for thin film resistor

Electroless NiP plating is widely used for many devices such as nonmagnetic underlayer of hard disk because of easily controllability of film properties by changing bath composition and codeposition of other metal. An amorphous NiP films with high phosphorus content (>10 at%) show a high resistivity and low temperature coefficient of resistance (TCR), so the films were sometimes used for thin film resistor. However, amorphous condition films are generally unstable with annealing at high temperature, and high resistivity was lost after annealing because of resulting structural changes. Therefore, codeposition of refractory metals, W, Mo, and Re, in electroless NiP films were studied to improve thermal stability and to increase the resistivity [2]. The NiWP and NiReP show high resistivity compared with resistivity of NiP films with 150 μΩcm, and especially $Ni_{51}Re_{44}P_5$ film shows high resistivity of 3000 μΩcm. Moreover, the resistivity of each films annealed at 400 – 500 ^{o}C showed high value of over 150 μΩcm, and the values were very stable compared with that of NiP film. Especially, the value of NiReP film was maintained at a more constant level than others, so this electroless NiReP films was applied to thin film resistor. Recently, higher resistivity NiP based films was developed using the bath containing the complexing agent with amino groups, and the amorphous NiP film deposited from the bath containing diethylenetriamine as a complexing agent showed very high resistivity of 5400 μΩcm [3]. Small amount of carbon was codeposited in the NiP films from the complexing agent, and it was suggested that high resistivity was realized by this small amount of impurity.

Electroless Cu and other films for ULSI technologies

Electroless-plated Cu films have been used as conductor and connector in printed circuits board (PCB). Recently, Cu electroplating called “Damascene process” have used for ULSI interconnection technology since 1997 [4], and electrochemical process has been used in the field of semiconductor industry. In the near future, the pattern dimension was finer and smaller, so electroless plating to the filed has been attracting attention as the new and attractive process. Y. Shacham-Diamand et al. reported to applying electroless Cu plating to ULSI interconnection technologies [5]. Moreover, the barrier layer as suppression of Cu diffusion is needed for Cu interconnection. It is reported that electroless CoWP films was very suitable for barrier layer [5]. We reported the potential to apply electroless Ni alloy films such as NiWP and NiReP to the aim of application to barrier layer [6]. However, the diffusion barrier layer has to be formed on interlevel dielectrics of SiO_2. Thus, the fabrication process of electroless films on SiO_2 without sputtered seed layer was needed. A self-assembled monolayer of silane were utilized as an adhesion/catalyzed layer, and we succeeded the fabrication of electroless NiReP film on SiO_2 layer without sputtered seed layer. Although this process is still under construction, it has a great potential for realization of all-wet process integration for microelectronics [6].

Electroless Co and Co alloy films for magnetic devices

Co, Ni, Fe and their alloy films prepared by electrochemical processes were widely used for magnetic recording devises, because of their magnetic properties. Electroless CoP and CoP based alloy films had high coercivity, therefore these films were used for magnetic recording layer of hard disk media. In 1981, electroless CoNiP film media were utilized by NTT as standard materials for the PATTY high density storage system [2]. Magnetic properties of the films was strongly influenced by impurities of metal ion in the plating bath, so controlling small amount of chemical agent was very important to obtain such a magnetic thin films. Magnetic recording head has been developed by electroplating method since 1979, and still now electroplating is used for their developing method. Recently, magnetic recording density is rapidly increased, so smaller head with higher performance core materials is strongly required. Electroless-plated soft magnetic films has been attracting attention as the new and attractive process. We have developed electroless CoNiFeB soft magnetic films with high saturation magnetic flux density and low coercivity, that is required for high density recording core materials [7]. Now the micro-patterned fabrication process has been succeeded with electroless soft magnetic thin films for the head core application [8]. Therefore, electroless high performance soft magnetic film is a candidate as core materials for higher-density magnetic recording head.

In conclusion, high performance electroless plated films could be realized by strictly controlling small amount of chemical agent in the bath and film composition, and structure. Electroless plating has a high potential to realize high performance electronic devices, and This method becomes much important for the future in the electronics field.

References

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