Copper thin films deposition by atmospheric aerosol CVD

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DEPOSITION CONDITIONS

The deposition process is based on the pyrolysis of an aerosol produced by an ultrasonic piezoelectric transducer and it is described elsewhere [1]. For the deposition of copper thin films we have used copper trifluoroacetylacetonate (TFA) or hexafluoroacetylacetonate (HFA) dissolved in butanol at a concentration of 0.03mol/l. The deposition temperature ranged between 280°C and 380°C. In order to avoid the oxidation of the films a mixture of N_2-H_2(10%) was used as carrier gas. But this solution was not enough efficient to prevent a partial oxidation of the deposited films. The oxidation didn't occur during the film growth but only during the cooling of the sample as observed by a colour change of the deposited film. This fact might be induced by the reducing character of the chemical atmosphere created by the pyrolysis of the aerosol. So a modified cooling procedure was used. During this new procedure the aerosol flow was kept until 150°C and a fast cooling was performed by using a modified heat plate cooled by internal air flow. With this set-up the cooling time between 300°C and 150°C was under 2 min and pure copper films with a well metallic aspect were obtained.

RESULTS

According to the deposition temperature the morphological aspect of the deposited films are observed by SEM. As shown on figure 1, at high deposition temperature the films exhibited large grains and a powder aspect whereas at low deposition temperature around 300°C the layers were more smooth and dense with smaller grains. As revealed by X-ray diffraction (figure2), all the films obtained with the new cooling procedure were pure copper without trace of copper oxide. The deposition rate ranged between 0.5 and 2 µm/h. The maximum was obtained at 320°C and 300°C for the films deposited with TFA and HFA respectively. The resistivity of the films was measured by a four probe method by using different current value in order to check the linearity. The best films exhibited a resistivity close to the bulk value (Fig.3). For the layers deposited with Cu TFA the lowest resistivity value was obtained at 320°C and at higher temperature a slight increase was observed. Whereas for films deposited with Cu HFA by increasing the deposition temperature a larger increase was observed and the lowest value was obtained at 300°C. More over this film exhibited also a high 111 texture and the highest deposition rate. The increase of resistivity by increasing the deposition temperature was in good agreement with the study of D.Temple (2). But in our case the minimum value was smaller and very close to the bulk value and we believed that this fact can be attributed to the reducing atmosphere induced by the aerosol.

REFERENCES

1. J.L. Deschanvres, Thin Solid Films, **175**, 281 (1989)
2. D. Temple, J.Electrochem. Soc., **136**, 3525 (1989).

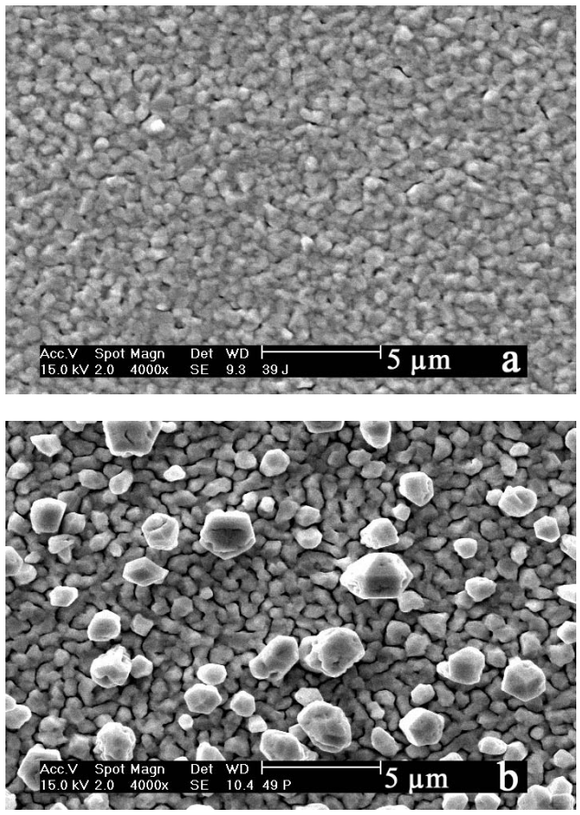

Figure 1: SEM observation of Cufilms deposited at 300°C (a) and 380°C (b)

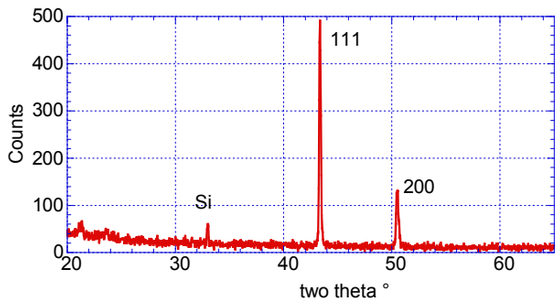

Figure 2 : X ray diffractogram of Cu layer deposited on Si wafer

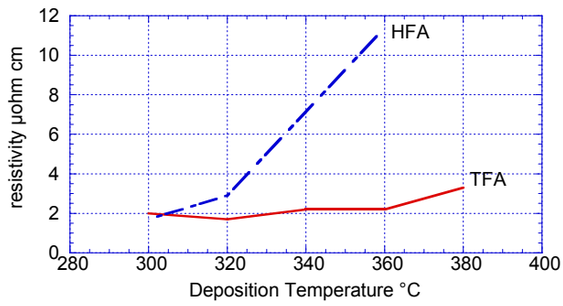

Figure 3 : Resistivity versus the deposition temperature for Cu films deposited with HFA or TFA.