Microscale metal patterning using photo-definable Ag based ternary organometallic compounds

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As the size of Liquid Crystal Displays (LCDs) increases, low resistivity metal is required to minimize the RC delay. Cu has been intensively studied for next generation metal in semiconductor and LCDs area.[1] Silver is well known to have lower resistance and better electromigration properties than Cu.[2] Silver film has been produced using several techniques including evaporation, sputtering, and electroplating,[3] however problems such as poor adhesion and corrosion properties are not solved yet.

The lithographic process currently used to define metal lines involves many steps. The complexity of process has the potential to introduce errors into the final pattern. We previously reported simple patterning process using photo-definable organometallic Ag precursor.[4] In this process, light sensitive organometallic Ag complex is spin-coated on substrate. Deep UV irradiation through a patterned mask selectively produces pure metal using photoreduction (spin on metal (SOM) process). However Ag films formed by SOM process suffer the same problems as films formed by other techniques (e.g. formation of silver corrosion layers, poor adhesion). Recently, it was reported that stability of Ag film was much better after using binary and ternary system than pure Ag.[5] In this paper, we report the synthesis and characterization of photo-definable Ag based alloy systems especially, ternary systems for SOM method.

In this experiment, small amount of Au and Cu metal complex are added to Ag solution to form Ag-Cu-Au ternary system. Metal film was formed by the method described above. Basic film properties including adhesion, resistivity, and reflectance are summarized in Table 1. Ag based ternary films showed the better adhesion properties than pure Ag films without deteriorating the reflectance. The stability of films is compared using the pressure cooking test. In this test, films are annealed at 110°C for 2 hours under humid atmosphere. The reflectance of sample is measured prior to (Rp) and after (Ra) the treatment. The reduction of reflectance is minimal with Ag-Cu-Au films compared with other films as shown in table 2. This result indicates that corrosion resistance improved after adding Au and Cu.

Silver metal patterns can be obtained using SOM method through photoreduction of precursor. The film stability can be improved using Ag based ternary system. This kinetic control of material synthesis will open up numerous possibilities for new preparations of materials.

Sample	Adhesion (%)	Resistivity ($\mu\Omega$cm)	Reflectance (at 700 nm)
Ag (sputter)	100	2.2	296
Ag(SOM)	40~50	7	283
AgCuAu(SOM)	120	15	281

Table 1. Properties of sputtered Ag, SOM Ag, and SOM Ag-Cu-Au films.

Sample	Ra/Rp at 480 nm	Ra/Rp at 633 nm	Ra/Rp at 700 nm
Ag (sputter)	39.6	53.2	57.7
Ag(SOM)	19.6	22.2	24.1
AgCuAu(SOM)	86.9	91.5	92.6

Table 2. Ratio of reflectance of Ag samples prior to and after annealing at 110°C for 2 hours under humid atmosphere.

References

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