SAM Nano/Micro Patterning and Its Application to Site-Selective Metallization

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Site-selective metallization on various substrates is a key technology for electronics packaging. We are developing two site-selective metallization methods by using patterned self-assembled monolayers (SAMs) with electroless plating, and a combination of electroless plating and transferring. Nano/micropatterned SAMs are good templates for many applications.

First we fabricated nanometer- and micrometer-sized patterns of SAMs. A SAM was formed on silicon substrates covered with/without native silicon oxide or plastic ones by chemical vapor deposition (CVD) using octadecyltrimethoxysilane (ODS), fluoroalkylsilane (FAS), p-aminophenyltrimethoxysilane (APhS), or undecanol as a precursor. Next we used two methods of patterning; the first was photolithography with vacuum ultra-violet light （VUV）at 172 nm, and the second was scanning probe lithography based on electrolysis induced locally under an AFM probe. Patterns on SAM nano/microstructures were imaged on a minute scale by atomic force microscopy (AFM) and lateral force microscopy (LFM).

Second we deposited metals like nickel, gold and copper onto patterned substrates by electroless plating. The nickel pattern on a silicon substrate is shown in Fig. 1. The minimum width of a metal line of 500 nm was obtained by VUV lithography. The much minute one down to 20 nm was done by scanning probe lithography. By using these SAM lithography methods and electroless plating we can make metal wirings from the micrometer size to the nanometer one on various types of substrates.

Third we explain the transferring method. We transferred the metal patterns to plastic substrates by an imprinting method as follows. (1) We made FAS-SAM patterns on a silicon substrate covered by native oxide. (2) We deposited the ODS-SAM onto silicon oxide regions, where the FAS-SAM was removed, and fabricated FAS/ODS patterns on silicon. (3) We deposited nickel onto only ODS regions by electroless plating and made a micropatterned-nickel mold as shown in Fig. 2. (4) A polymethylmethacrylate (PMMA) substrate formed by spin coating was imprinted onto the micropatterned-nickel mold. (5) After releasing the mold we fabricated the micropatterned nickel on the PMMA substrate as shown in Fig. 3. We can use the ODS/FAS patterns many times for nickel deposition. Therefore this micropatterned nickel mold is reusable many times. This method is applicable to other metals. By this method we can make the micropatterned metal on plastic substrates with low cost.

In conclusion SAMs are very useful for site-selective metallization on various substrates.

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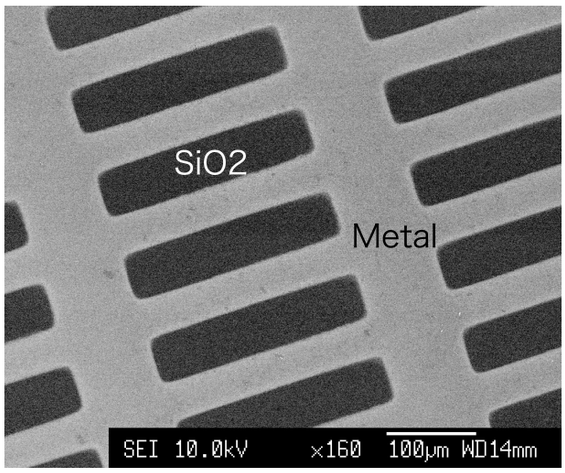

Fig. 1 A nickel micropattern on the silicon substrate prepared by using SAM patterning and electroless plating.

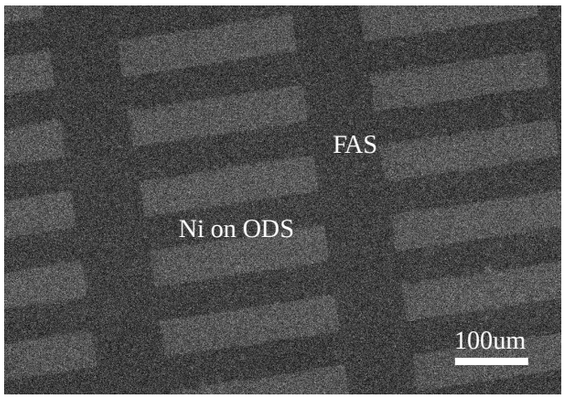

Fig. 2 A micropatterned nickel mold prepared on a ODS/FAS pattern.

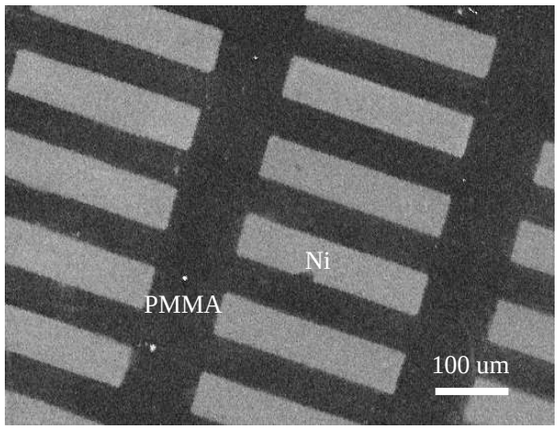

Fig. 3 A nickel micropattern transferred onto a PMMA substrate.