

The films were irradiated for 30 minutes with the lamp output adjusted to 7mW/cm<sup>2</sup> at 254 nm. The wafers were then processed through the standard plating sequence, using chemicals from Shipley Co. A thin (ca. 50 nm thick), continuous metal pattern developed preferentially in the masked regions of the film-coated substrate. In the case of the CMPTC and CTP silane, essentially no plating was observed in the unmasked regions.

As in Example 28, the presence of a moiety in the film such as a phenyl group that can absorb light at longer wavelengths than a group such as an isolated olefin, endows the film with photosensitivity at those longer wavelengths. However, the improved contrast between the plated and unplated regions for the CMPTC and CTP silane, as opposed to the lower contrast observed with the ethylpyridinyl silane used in Example 28 and DPVC, indicates the importance of the position of the aromatic group in the molecule.

The origin of the contrast development, as currently envisioned, involves the absorption of light by a chromophore in the film that causes photolytic cleavage of the molecule at, or in the vicinity, of the chromophoric group. When less energetic radiation, e.g. longer wavelengths than 220 nm, is employed for patterning, chromophores such as phenyl or pyridine rings can be excited but chromophores that do not absorb at these longer wavelengths will not be excited. With films that have chromophores sensitive to this radiation at positions remote from the silicon atom, photolytic cleavage may occur only at that position, leaving attached to the silicon atom organic moieties such as methyl, vinyl and methylene groups. The surface therefore has patterns of the original film in the masked areas intermingled with partially cleaved film in the exposed areas. This may be the case with the DPVC film, where the phenyl rings are cleaved and the vinyl group remains. The partially cleaved molecules may still bind the Pd/Sn colloid sufficiently well to cause plating to occur in the exposed areas, although of poorer quality and coverage than in the unexposed regions. If films with only aromatic groups directly bonded to the silicon atom are employed, then photolytic cleavage would cause removal of all the organic portions of the molecule at the silicon atom. This would result in an analogous situation to when sub-200 nm radiation is employed, because most organic moieties absorb sub-200 nm radiation and would therefore be cleaved.

#### EXAMPLE 33

Selective metal plating of p-chloromethylphenyltrichlorosilane can be carried out using a KrF excimer laser as the exposure tool.

Wafers were treated as in Example 32 with the CMPTC silane and exposed through a quartz mask with a KrF (248 nm) Lambda Physik excimer laser. The pulse intensity of the laser was approximately 400 mJ/cm<sup>2</sup> and the wafer was exposed for 5 and 7 seconds at a pulse rate of 4 Hz. The total dosage delivered to the wafer was 8.5 J/cm<sup>2</sup> and 11.9 J/cm<sup>2</sup>.

The wafers were then processed through the standard plating sequence using chemicals from Shipley Co. A thin continuous metal pattern with sub-micron features developed preferentially in the masked regions of the film-coated substrate and, essentially no plating was observed in the unmasked regions.

#### EXAMPLE 34

Selective metallization can be carried out on silane films having aromatic groups bound via a spacer group to the silicon atom. Ultrathin films of silanes having aromatic groups bonded via a spacer group to the silicon atom were prepared on clean polysilicon surfaces using standard procedures that have been described for the other silane materials. The silanes (obtained from Petrarch Co., Bristol, PA) employed were: trichloro-(4-pyridyl) ethylsilane (pyridyl silane), and 7-[3-(chlorodimethylsilyl)propoxy]-4-methylcoumarin (coumarin silane). The film-coated substrates were exposed to masked irradiation from a mercury/argon lamp as in Example 3. The films were irradiated for 30 minutes. The wafers were then processed through the standard plating sequence, using chemicals from Shipley Co. A thin (ca. 50 nm thick), continuous metal pattern developed only in the masked regions of the film-coated substrates.

While the theory of operation of the invention is uncertain, it is believed that the radiation acts to remove at least organic groups present on the surface of organic substrates where they are used. For example, in Example 10, the infrared spectra of silane monolayer films after radiation with deep UV light showed that the organic groups (e.g., methyl groups, octenyl groups) were no longer detectable. It is believed that at least the organic groups were removed from the film in the irradiated areas either by photolytic cleavage of the Si—C and/or Si—O—(surface) bonds and possibly C—C bonds as well. It is believed that although organic parts are removed from the silane film by radiation, a significant amount of the silicon from silane deposit remains on the surface after radiation and it is theorized that photolytic cleavage occurs preferentially at the Si—C and C—C bonds rather than at the Si—O bonds and further that at least a partial atomic layer of silicon oxide is left after irradiation. Because of the known reactivity of freshly cleaved or sputted Si, the photolytic product likely reacts rapidly with an ambient atmosphere to produce surface Si—OH and/or Si—O groups. It can be demonstrated that the silicon oxide can be built up selectively with atomic resolution in the Z direction and sub-micron resolution in the XY directions (where X and Y are in the plane of the film and Z is perpendicular to the substrate). It is expected that one could build patterned molecular assemblies of silicon oxides by successive film deposition and photolytic cleavage steps. Therefore, one could fabricate silicon based semiconductive microcircuits using a bottom up approach, eliminating the need for any etching steps. Similarly, the mechanism operative for silane films could be operative for titanates, zirconates, and aluminates such that molecular assemblies consisting of titanium oxides, zirconium oxides, aluminum oxides and related surface reactive agents or combinations of these can be built up selectively.

While the metal layer is the preferred material for patterning and deposition as for use in printed circuits and the like, the layer to be applied to the substrate can be of inorganic materials, organic materials, semiconductive materials, metals or combinations thereof. While a layer is preferably provided independently over and adherent to a substrate, which layer is a radiation reactive material, as for example by the use of a silane on an organic substrate, in some cases, the surface of the