PATTERN FORMING METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a pattern forming method which can be used in manufacture of semiconductor elements, printing plates, etc., and particularly relates to a pattern forming method of selectively forming a film on an arbitrary substrate by use of chemical vapor reactions.

Heretofore, resist patterns in the manufacture of semiconductor elements or resin patterns which provide negative plates in the manufacture of printing plates have been manufactured in the following manner; A resin film which may be polymerized or decomposed by irradiation of light is formed on the substrate and, then, light beam are irradiated in any arbitrary pattern on the resin film, followed by development, thereby forming the pattern. More and more refining of these resist patterns has become demanded for attainment of higher density of semiconductor elements and higher quality of printed forms.

Particularly, in the manufacture of a very large scale integrated circuit (VLSI), there has arisen the need for forming at a high accuracy a resist pattern in fine lines of submicron order. While this process is largely affected by the physical properties of the resist itself, generally, the finer the desired pattern (thus, for increasing the resolution), the resist film applied needs to thinner. On the other hand, when it comes down to providing submicron patterns, wet etching can not be utilized, but such a dry etching as ion etching, plasma etching or sputter etching, etc., must be utilized. In order to improve the dry etching resistance of the resist pattern, generally, the resist coating needs to be thick.

Accordingly, in order to meet the above-stated two requirements, it is advisable to develop a photoresist whose coating is thick, but gives high resolution, or a photoresist whose coating is thin but gives high dry-etching resistance. However, presently, there is no such material available.

SUMMARY OF THE INVENTION

It is the object of this invention to provide a method for forming a pattern which has high resolution and excellent etching resistance.

This and other objects will be accomplished by a pattern forming method which comprises the steps of forming on a substrate a responsive film containing responsive groups which undergo chemical reactions under irradiation by an energy beam, deactivating the responsive groups in a pattern by irradiating energy beams in the pattern onto said responsive film to thereby form an irradiated film, and irradiating the entire surface of said irradiated film with energy beams, after placing the substrate having the irradiated film forms, in a polymerizing monomer atmosphere to additionally polymerize said polymerizing monomer onto the responsive film except for said irradiated film area, thereby forming a polymerized film in a pattern.

In a specific embodiment, in the step of forming a responsive film, a monomolecular responsive film is formed so that the responsive groups may be exposed in line on the substrate surface by the LangmuirBlodgett process, adsorption method or the like. As a polymerizing monomer, a substance containing Si is used. After forming a photosensitive film on an arbitrary substrate through an organic film, a polymerized film in a pattern is formed by a substance selectively containing Si, and is processed by oxygen plasma, thereby transferring the pattern containing Si onto said organic film. As the responsive group of the responsive film and as the polymerizing group of the polymerizing monomer, the vinyl group or ethynyl group is contained.

This invention has various advantages, among which is its capability of forming the pattern at a high resolution and with excellent etching resistance.

While the novel features of the invention are set forth with particularity in the appended claims, the invention, both as to its organization and content, will be better understood and appreciated, along with other objects and features thereof, from the following detailed description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1(*a*)-(*f*) are sectional views showing the steps of a first embodiment for explanation of the method of this invention, (*a*), (*c*) and (*e*) of this figure representing conceptual views of a section of the substrate in the successive steps, and (*b*), (*d*) and (*f*) of this figure expanded views at the molecule level of the parts A-C indicated in (*a*), (*c*) and (*e*) respectively;

FIGS. 2(*a*)-(*c*) are sectional views showing the steps of the second embodiment of this invention, conceptual diagrams for explanation of the steps of transferring the pattern of the organic film, following the process of the first embodiment;

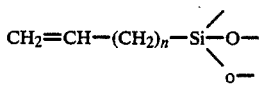
FIG. 3 is sectional view for explaining a third embodiment of the invention, which view corresponds to the step of FIG. 1(*e*).

DETAILED DESCRIPTION OF THE INVENTION

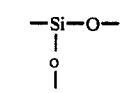
In the following, embodiments of the pattern forming method of this invention are described with reference to FIGS. 1-3.

Embodiment 1

A first embodiment of this invention is described with reference to FIG. 1. On a Si substrate **10** formed with SiO_2, there is formed by chemical adsorption process, a monomolecular film **12** of



through the reaction of the surface substrate with a silane surface active agent, e.g., $CH_2{=}CH{-}(CH_2)_n{-}SiCl_3$ (n represents an integer, preferably being 10-20, $CH_2{=}CH{-}$ may be $CH{\equiv}CH{-}$). For example, the treated substrate is dipped in a silane surface active agent solution of this surfactant at a concentration of $2.0\times10^{-3}-5.0\times10^{-2}$ mol/l in 80% n-hexane, 12% carbon tetrachloride and 8% chloroform, to form a bonding **14** of



at the SiO_2 surface [FIG. 1(*a*)].