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August 21, 2009

Re: 6319-122637

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Japanese Kokai Patent Application No. Hei 4[1992]-71222

Job No.: 6319-122637 Ref.: JP04071222A
Translated from Japanese by the McElroy Translation Company
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(19) JAPANESE PATENT OFFICE (JP)
(12) KOKAI TOKUHYO PATENT GAZETTE (A)
(11) PATENT APPLICATION KOKAI PUBLICATION NO. HEI 4[1992]-71222
(43) Publication Date: March 5, 1992

(51) Int. Cl.[5]:	Identification Codes:	Sequence Nos. for Office Use:		
H 01 L 21/027	511			
G 03 F 7/26		7124-2H		
7/40		7124-2H		
		7352-4M	H 01 L 21/30	361 S
		7352-4M		361 P

Examination Request: Not filed No. of Claims: 2 (Total of 5 pages)

(54) Title PATTERN FORMING METHOD

(21) Filing No.: Hei 2[1990]-184447
(22) Filing Date: July 12, 1990

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Claims

1. A pattern forming method characterized in comprising:

a process to form a first resist on a substrate and to pattern said first resist,

a process to insolubilize the first resist pattern obtained with the aforementioned pattern relative to the solvent for a second resist formed later on the aforementioned substrate having said first resist pattern and to the developer used later for developing said second resist, performed,

and a process to form said second resist on the aforementioned substrate having said first resist pattern which has been insolubilized and to pattern said second resist.

2. The pattern forming method described in Claim 1, characterized in that the abovementioned insolubilizing treatment is performed by placing the substrate having the aforementioned first resist pattern in a gas plasma that contains a fluorine compound gas in which the hydrogen in an alkane has been replaced with fluorine,

Detailed explanation of the invention

Industrial application field

The present invention relates to a pattern forming method used in the process of manufacturing semiconductor devices or the like.

Prior art

Projection exposure apparatuses are widely used to manufacture IC, LSI and other semiconductor devices.

In the past, when a resist pattern has been formed using a projection exposure apparatus, the procedure generally used has been to coat a substrate, such as a silicon wafer, with a resist, expose the resist with the projection exposure apparatus, and then develop the resist and obtain the final resist pattern.

The resolving power R (critical dimensions at which line and space dimensions can be resolved to be equal to each other) of the projection exposure apparatus in a process such as this is given by Equation 1 below.

$$R = k\lambda / NA \quad \cdots (1)$$

Here, k is a constant and is usually around 0.6, but this is a value that varies somewhat according to the process. λ is the wavelength of the exposure light, and NA is the numerical aperture of the projection exposure apparatus projection lens.

Therefore, in order to obtain the highest resolving power possible to handle miniaturization in semiconductor device design rules, exposure light wavelengths have been shortened and projection lens NA has been made higher.

Projection exposure apparatuses with higher NA that are currently available include those using exposure light of g rays (436 nm) and with NA of 0.54, and those using exposure light of i rays (365 nm) and with NA of 0.45.

Concerning the resolution of these projection exposure apparatuses, letting k in abovementioned Equation (1) be 0.6, the resolving power R_1 of the former will be

$$R_1 = 0.6 \times 436 / 0.54$$
$$= 484\,nm \fallingdotseq 0.5\,\mu m$$

and resolving power R_2 of the latter will be

$$R_2 = 0.6 \times 365 / 0.45$$
$$= 487\,nm \fallingdotseq 0.5\,\mu m$$

That is, these projection exposure apparatuses are capable of patterning at about 0.5 µm, and the manufacture of 16 Mbit DRAMs and the like is possible.

Problems to be solved by the invention

However, there are limits to increasing the NA of the projection exposure apparatus projection lens due to the difficulty of lens manufacture. In concrete terms, NA is 0.65 for those for g rays, and for i rays it is 0.60. With those for KrF excimer lasers (248 nm wavelength), 0.5 is about the limit. Therefore, the resolving power under these conditions will be 0.4, 0.36, and 0.30 µm, respectively, in accordance with Equation 1 (assuming k = 0.6). For this reason, with pattern formation using conventional pattern forming methods using these exposure apparatuses (methods in which a resist is exposed and then developed to obtain the final resist pattern), pattern formation for design rules of 0.25 µm or less has been difficult.

This invention was devised taking these points into consideration. Therefore, the objective of this invention is to provide a pattern forming method with which resist patterns below the resolution limit of the projection exposure apparatus can be formed.

Means to solve the problems

In order to accomplish this objective, the pattern forming method of the present invention is characterized in comprising:

a process to form a first resist on a substrate and to pattern said first resist,

a process to insolubilize the first resist pattern obtained with the aforementioned pattern relative to the solvent for a second resist formed later on the aforementioned substrate having said first resist pattern and to the developer used later for developing said second resist,

and a process to form said second resist on the aforementioned substrate having said first resist pattern which has been insolubilized and to pattern said second resist.

To implement this invention, it is ideal to perform the abovementioned insolubilizing treatment by placing the substrate having the abovementioned first resist in a plasma containing a fluorine compound gas in which the hydrogen in an alkane has been replaced with fluorine.

Note that the substrate referred to here is, for example, a glass substrate, a silicon substrate, a GaAs substrate or other type of substrate, or an insulating film on the substrate, a metal film or other thin film, and/or an intermediate body in which elements are constructed.

Operation

With the construction of this invention, a first resist pattern and a second resist pattern are arranged in a prescribed relationship on a substrate (for example, a space of the second resist pattern is arranged in an area corresponding to a space section of the first resist pattern on the substrate) for forming resist patterns, and the patterns can become the final resist pattern. Therefore, even through both the first resist pattern and the second resist pattern are patterns with dimensions within the resolution limits of the projection exposure apparatus used, the final resist

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