

Description

Thermal Treatment Process of Positive Photoresist Composition

Background Of The Invention

5 In the typical microlithographic process used in the semiconductor industry, the photoresist material is applied to the semiconductor substrate by spin-coating. After the spin-coating step, the resist material, which still contains a large amount of solvent (up to an estimated 30%), is still very soft and tacky. In this state, it would not offer resistance to the developer even in the unexposed parts. It must, therefore, be dried and densified in a thermal treatment step commonly called a softbake or
10 prebake. The softbake can be carried out on a hotplate device or in an air oven. On hotplates, the back side of the substrate carrying the resist layer is brought into contact or close proximity to the hot metal surface of the hotplate for a time of 60 to 90 seconds, most typically 60 seconds, a time which has become a kind of standard in the industry. Typically, oven softbakes use even longer times, e.g., a popular
15 condition is 90°C for 30 min.

During spin coating, the resist has become highly viscous and has for practical purposes stopped flowing, as evidenced by its failure to planarize topography on substrates which have it. The film is still far from thermodynamic equilibrium, containing a large amount of free volume which to a good extent is taken up by
20 solvent. During the softbake, the resist is heated above its initial flow point again; it may become a liquid for a short time until loss of solvent and densification cause it to solidify again. This process is accompanied by a reduction in film thickness. For some types of resists, for example single-polymer e-beam resists such as hexafluoroisopropylmethacrylate, the bake temperature can be chosen to be above the
25 glass transition temperature of the polymer. In this case, the film comes close to thermodynamic equilibrium. For the diazonaphthoquinone resists most commonly used in the semiconductor industry, however, the maximum bake temperature is limited by the thermal decomposition of the diazonaphthoquinone sensitizer (DNQ). The isothermal decomposition temperatures for DNQs typically used in the industry range
30 from 120°C for trihydroxybenzophenone derivatives to about 130°C for non-

benzophenone backbones. Usually much lower temperatures are used because with monochromatic radiation such as typically used in g- or i-line wafer steppers, light moving towards the surface and light reflected from the surface interfere to form a standing wave pattern. If the wafer is developed without an additional bake step between exposure and development (a so-called Post-Exposure Bake, or PEB), this standing wave pattern is quite faithfully reproduced in the resist feature, leading to linewidth variations, resolution degradation and increases in the dose or development time to clear an exposed area. The conventional remedy is to carry out a PEB, during which diffusion effects cause an intermixing of the photoproducts and the intact DNQ. The standing wave pattern is smeared out by this diffusion process to a degree that it is be completely unobservable in many practical resist processes.

However, in order to be able to carry out the diffusion process with sufficient effectiveness, it is typically necessary to carry out the PEB at higher temperatures than the softbake. A typical combination is a softbake of 90°C for 60 seconds, followed by a PEB of 110°C for 60 seconds. Processes in which SB and PEB are carried out at the same temperature are rare, and the inventors know of no practical process in which the SB exceeds the PEB. Under the latter conditions, the SB would harden the resist matrix to the extent that the standing wave could not be diffused out, leading to the above-mentioned undesirable phenomena.

These considerations change if the resist substrate is essentially non-reflecting, such as when it is covered with an antireflective coating. With these coatings (either inorganic layers such as titanium nitride (TiN) or organic layers, one example for which is the AZ® BARLi™ coating sold by the AZ Photoresist Products Division of Hoechst Celanese Corp., the substrate reflectivity can be reduced to a few percent of the original one. For TiN, the minimum reflectivity is calculated to be around 3-3.5 percent at a thickness of 50 nm (on a silicon substrate); the reflectivity of the organic bottom layers can be reduced to less than one tenth that, which makes the standing wave pattern sufficiently weak that a post exposure bake is no longer required.

Elimination of the PEB brings further advantages beyond the simplification of the process. At the elevated temperature of the PEB, the photoproducts of the diazonaphthoquinone are able to diffuse for certain distances, which leads to the

smearing-out removal of the standing waves present on reflective substrates. A certain amount of diffusion is thus desirable in this case. On non-reflective substrates such as bottom coats, however, the degradation of the latent image in the photoresist by the diffusion process outweigh the benefits of the PEB. Experimental observation
5 also confirms this: on antireflective bottom coats, such as AZ[®]'s BARLi[™] material, the resolution of commercial resists, such as AZ[®]7800 i-line resist, is enhanced if a PEB is omitted (e.g., from 0.34 to 0.32 μm (micrometer) lines and spaces in a ca. 1 μm (micrometer) resist, see Example 1).

The present invention provides a further improvement in photoresist resolution
10 and performance by using a higher than conventional soft-baking (SB) temperature ($\geq 130^\circ\text{C}$) and a very short baking time (≤ 30 seconds) of the resist. This process will in the following be referred to as the "flashbake" process. It should be noted that the benefits of the flashbake are not obtained unless it is carried out over a bottom antireflective coating, such as TiN or AZ[®] BARLi[™] coating. The flashbake process
15 significantly improves the photoresist's resolution, process latitude, thermal deformation temperature, resist adhesion and plasma etch resistance.

Without wishing to be bound by theory, we believe that the flashbake process enhances resist performance because it allows more effective drying and densification of the photoresist than conventional softbake processes. In spin coating, the
20 photoresist stops thinning and reaches a non-fluid state which still contains large amounts of solvent. In conventional softbaking, the rise in temperature initially brings the resist back into a fluid state in which solvent can efficiently escape from the resist. However, the resist quickly is brought back into a non-fluid, glassy state as the evaporation of solvent hardens the matrix. Solvent cannot escape efficiently once the
25 resist matrix has been thus hardened. It is well known that even after long temperature treatments, e.g., convection oven bakes for 30 minutes, the resist still contains essentially the same amount of solvent that is found after the much shorter hot plate bakes at the same temperature. We conclude from that that most of the solvent evaporation occurs in the initial period in which the resist is still fluid.

30 During the short time of the flashbake process, the resist and wafer do not reach the temperature of the hotplate. Measurements of the wafer temperature show

that the wafer is still about 5-10°C below a hotplate temperature of 140°C after 20 seconds. Therefore we believe that the resist remains in a fluid state during the entire flashbake process, leading to a more thorough drying of the film which causes the completely unexpected and unforeseen improvement in the thermal stability of the resist. As shown in Example 3, the thermal stability obtained with the flashbake process is higher by 20 to 30°C than with a conventional softbake process.

Moreover, we believe that the flashback films are closer to thermodynamic equilibrium than the films obtained by the longer conventional softbakes at lower temperature. All resist films contain a large amount of free volume after spincoating and baking. This free volume can only be removed if the resist is baked above its glass transition temperature, allowing the polymer strings to relax and form a new, more densely packed order. This can be done for thermally stable resists such as polymethylmethacrylate (PMMA) and hexafluoroisopropylmethacrylate, but not for novolak films because the temperatures necessary would lead to thermal decomposition of the sensitizer, further hardening the matrix by crosslinking effects and causing a deterioration of the imaging properties. We believe that the new flashbake process leaves the resist in a state with reduced free volume, and that this reduced free volume allows better dissolution properties leading to the observed resolution enhancement.

The free volume effects mentioned above will be expected to be particularly strong in resists which have high glass transition temperatures, e.g., one such class of resists is that of DUV resists based on t-butoxycarbonyl-protected polyhydroxystyrene, in which the free volume leads to undesirable effects due to the facile diffusion of base contaminants. Another example for such a class is that of diazonaphthoquinone/novolak resists which make use of fractionated resins, i.e., resins in which part or all of the low-MW components typically present in a novolak synthesis by condensation of phenolic compounds and formaldehyde have been removed. There are many ways to achieve a molecular weight dependent fractionation. One which shall be discussed here, in order to illustrate the nature of the material, utilizes a molecular weight dependent miscibility gap of the novolak in a mixture of good and bad solvent. Upon admixture of the bad solvent to a solution of the novolak in the good solvent, two

phases separate, although the good and bad solvent may be fully miscible. The lower phase contains the high-MW novolak, with the low-MW materials remaining in the (typically larger) upper phase. By variation of concentrations and ratios of the solvents, it is possible to achieve control over the maximum MW removed and the degree of removal of the low MW fractions. Due to the lack of low-MW fractions, resists based on fractionated novolaks will have higher glass transition temperatures, hence they tend to solidify more quickly during spin coating and conventional softbaking.

In DNQ/novolak resists, fractionation very often causes a large reduction of the resist sensitivity. One therefore often admixes monomeric or low-MW polymeric components to the resist in order to achieve higher sensitivity. Resists of this type will also be expected to benefit from the process of this invention.

Besides the nature of the resin, the nature of the sensitizer, in particular its thermal stability, is also important in considering the effect of high-temperature bakes on the resist performance. In the experience of the inventors, there is a distinct sequence of stability for diazonaphthoquinone (DNQ) esters which is generally observed: 2,1,5-DNQs are more stable than 2,1,4-DNQs; aliphatic esters are less stable than aromatic esters; in aromatic esters, those which have 2 or more DNQ moieties attached to a single phenyl ring in the backbone (such as trihydroxybenzophenones) are less stable than non-benzophenone esters, especially those with only a single DNQ unit per phenyl ring. The highest stabilities are thus observed for 2,1,5-DNQ-sulfonates of backbones containing one or more monohydric phenols. Such compounds are anticipated to be particularly useful in the process of this invention, since their higher thermal stability will minimize undesirable side reactions of the high temperature bakes. The benefits of the flashbake process will therefore be greater for resists containing such backbones.

While the benefits derived from the flash softbake process are largest on a non-reflecting substrate, it is possible to use the process on a reflective substrate, such as a silicon wafer or metal layer. Under these circumstances, one will see substantial standing waves, limiting the available resolution and edge acuity for finer features. For larger features, it will, however, be possible to reap essentially the same thermal

stability benefits which are observed on antireflective substrates. The flash softbake process on reflecting substrates is therefore useful for large features, such as are encountered on pad or implant layers.

5 Summary Of The Invention

What is claimed is a process for preparing a relief image on a substrate of low reflectivity which comprises coating a photoresist on a substrate, baking the photoresist coating, and exposing the photoresist to actinic light. The bake step being carried out by bringing the substrate into contact or close proximity with a heated surface not lower in temperature than 130°C, for a period of no longer than 30 seconds (5-30 seconds). The temperature of the heated surface is preferentially between 130 to 160°C, most preferentially between 140 to 150°C. The baking time of the resist is preferentially lower than 20 seconds, most preferentially between 10 and 20 seconds. The bake process may be carried out on devices such as customarily used in the semiconductor industry, i.e. hotplates, optionally in the form of a proximity bake in which the distance between substrate and hotplate is regulated buy a distance holder device, e.g., balls inserted into the hotplate surface. The baked, exposed photoresist is then treated conventionally to develop the final image on the substrate.

20 The process of this invention significantly improves the photoresist's resolution, process latitude, thermal deformation temperature, resist adhesion and plasma etch resistance. It also eliminates the need for a post exposure bake (PEB) step during the photolithographic process, without causing a severe standing wave effect.

25 The photoresist used in the process of this invention is typically a diazonaphthoquinone/novolak resist, although non-diazonaphthoquinone, non-novolak based resists may also benefit from this process. The situation in which the diazonaphthoquinone sensitizer is thermally stable has proven particularly advantageous, since the higher thermal stability further reduces thermal decomposition effects of the sensitizer which otherwise might impair performance.

30 Thermal stability of diazonaphthoquinones is highly correlated to the backbone

structure. In particular, backbones which are neither aliphatic compounds nor derivatives of benzophenone often show higher thermal stability, in particular if they are aromatic compounds in which no more than a single hydroxy group is attached to any phenyl ring. The process of this invention is also perceived to be particularly advantageous for photoresists containing fractionated novolak resins, i.e., resins which have undergone a process in which the low molecular weight components present after synthesis have been partially or completely removed, since the process of this invention provides for a higher degree of densification and the presence of less free volume than can be accomplished with prior art processes. Most particularly, the reduction in free volume may be assisted by a combination of the fractionated resin with monomeric or low-MW speed enhancer compounds. Such compounds are frequently added to such resins in order to enhance the light sensitivity.

Example 1

The photoresist employed in the following experiment was AZ[®]7800 positive photoresist (available from AZ Photoresist Products, Hoechst Celanese Corporation, Somerville, NJ.), which contains a novolak resin and a 2,1,5 diazonaphthoquinone sulfonate ester photosensitizer in a mixture of Ethyl Lactate/n-Butyl Acetate as the casting solvent. The backbone of this photoresist is not a benzophenone derivative, and this PAC was found to be thermally highly stable.

A series of 4" silicon wafers were coated with 2500 Å of AZ[®] BARLi[™] coating on a MTI-Flexifab[®] coater and baked on a hot plate @ 170°C for 45 seconds. These BARLi[™]-coated wafers were further coated with the above photoresist to a thickness of 1.07 µm (micrometers). For comparison, wafer #1A and #1C listed in Table 1, the photoresist was directly coated on the silicon wafers. The wafers were soft baked (SB) on a hot plate at temperatures ranging from 90°C to 150°C for a period ranging from 10 seconds to 60 seconds. The baked wafers were then imagewise exposed with a NIKON[®] 0.54 NA i-line stepper using a reticle containing equal line&space patterns with linewidths from 0.2 µm (micrometers) to 1.0 µm (micrometers). The exposed wafers were developed with AZ[®] 300 MIF developer (2.38% tetramethyl ammonium hydroxide solution in water) for a specific

time, (60-120 seconds). The linewidth of the developed resist lines/spaces pattern were measured by a HITACHI® S-4000 scanning electron microscope. Table 1 summarizes the resist lithographic performance under the various process conditions.

Table 1: Lithographic performance for various process conditions

Wafer	Resist on BARLi™ coating	SB Temp./Time	PEB Temp./ Time	Dev. Time	DTP [mJ/cm²]	Resolution	DOF/0.34µm	DOF/0.30 µm
1A	No	90°C/60sec	110°C/60sec	70sec	190 mJ/cm²	0.34 µm	0.4 µm	<0.2 µm
1B	Yes	90°C/60sec	No	90sec	200 mJ/cm²	0.32 µm	0.8 µm	<0.2 µm
1C	No	140°C/10sec	No	90sec	230 mJ/cm²	0.34 µm	No/S.W.	No/S.W.
1D	Yes	130°C/10sec	No	90sec	210 mJ/cm²	0.32 µm	0.8 µm	<0.2 µm
1E	Yes	140°C/10sec	No	90sec	245 mJ/cm²	0.30 µm	1.0 µm	0.4 µm
1F	Yes	140°C/20sec	No	90sec	250 mJ/cm²	0.30 µm	1.0 µm	not measured
1G	Yes	150°C/10sec	No	90sec	290 mJ/cm²	0.32 µm	1.0 µm	<0.2 µm
1H	Yes	150°C/10sec	No	120sec	220 mJ/cm²	0.30 µm	1.0 µm	0.4 µm

5 where Dose-to-Print (DTP, in mJ/cm²) is the exposure dose required to replicate the targeted resist feature sizes to the targeted (mask) dimension. Resolution is defined as the smallest feature resolved which measures within $\pm 10\%$ of its targeted linewidth at DTP. The depth-of-focus (DOF) is defined as the range of the defocus in which a resist is able to replicate a feature with a measured linewidth within $\pm 10\%$ of the
 10 targeted feature, with the additional proviso that the film thickness loss is lower than 10%.

15 Wafer #1A in Table 1 represents the resist processed with conventional process conditions, i.e., a lower SB temperature(90°C/60 seconds) and a higher PEB temperature (110°C/60 seconds) were used to deliver good resist performance and eliminate the detrimental standing wave effect caused by the light reflective from the substrate. As evidenced by wafer #1C, if there is no PEB applied, a severe standing wave effect is observed. Application of a bottom antireflective coating (B.A.R.C.) such as AZ® BARLi™ coating offers improvement in resist resolution, DOF and also eliminates the need for the PEB step as evidenced by wafer #1B. The application of
 20 the very high SB temperature described in this invention (wafers # 1D-1H) gave unexpected advantages, significantly improving the resist resolution and DOF of the features (e.g., 0.30 µm (micrometer) resolution on a 0.54 NA i-line stepper with 0.40 µm (micrometer) DOF, wafer # 1H). This performance increase is a substantial

improvement over conventional processes used in the prior art, such as 90°C-110°C or B.A.R.C. coating alone, for which these parameters cannot be achieved with this resist and exposure tool combination.

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Example 2.

Four 10.16 cm (4") wafers were coated with BARLi™ coating under the same coating condition as used in the Example 1. Photoresist was then spun on, and the coated wafers were soft-baked on a hot plate at temperature of 140°C for 10, 20, 30 and 60 seconds (Wafers A, B, C and D). Each of the wafers was then exposed, developed and measured by the same process as described in Example 1. Table 2 summarizes the effect of the baking time on the resist performance for the flashbake process described in this invention.

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Table 2: Influence of Flashbake Times on Resist Performance

Wafer	BARLi	SB Temp./Time	PEB	Dev. Time	DTP	Resolution	DOF/0.34 μm
2A	Yes	140°C/10sec	No	90sec	245 mJ/cm ²	0.30μm	1.0μm
2B	Yes	140°C/20sec	No	90sec	250 mJ/cm ²	0.30μm	1.0μm
2C	Yes	140°C/30sec	No	90sec	250 mJ/cm ²	0.32μm	0.6μm
2D	Yes	140°C/60sec	No	90sec	550 mJ/cm ²	0.36μm	0.4μm

As can be seen from the Table 2, the resist performance is significantly improved by the flash SB process if the soft baking time is less than or equal to 30 seconds. Softbakes at temperatures greater than 130°C for longer than 30 seconds (60 seconds) will cause degradation on the resist performance, as evidenced by wafer #2D.

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Table 2 also provides information about the practical usefulness of the flashbake process. As can be seen by a comparison of wafers # 2A-C, the performance change is small in the range of 10-30 seconds, indicating sufficiently large latitude for the bake time. It is estimated from these data that for 140°C bake temperatures, the optimum bake time is approximately 15 seconds.

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Example 3.

Four 10.16 cm (4") wafers were coated with BARLi™ coating the same coating condition as used in the Example 1. Photoresist was then spun on, and the coated wafers were soft-baked on a hot plate using temperatures and times as listed in the Table 3. Each of the wafers was then imagewise exposed on a i-line stepper at the DTP values given in Table 1 to generate a 3 x 3 array of identical dies. The exposed wafers were developed by the same process as described in Example 1, using the developing time listed in Table 3 for each wafer. Each developed wafer was broken into 9 fragments, with each fragment containing a die image from the above 3 x 3 die array pattern. Each fragment was further baked on a hot plate for two minutes at the temperatures given in Table 3. The resist thermal flow temperature, defined as temperature which the edge of a 500 μm (micrometers) pad pattern on the die starts to deform, was then measured by SEM inspection. As can be seen by inspection of Table 3, wafers processed with the flashbake process described in this invention clearly offer much better resist thermal flow temperatures. The improvement can be as much as 30°C (see wafer #3C) over the resist processed with conventional SB process (see wafer#3A).

Table 3: Resist Thermal Flow Temperatures for
Conventional and Flashbake Processes

Wafer	BARLi™ coating	SB Temp./Time	PEB	Dev. Time	DTP	Thermal
3A	Yes	90°C/60sec	No	90sec	230 mJ/cm ²	115°C
3B	Yes	140°C/10sec	No	90sec	250 mJ/cm ²	135°C
3C	Yes	150°C/10sec	No	120sec	220 mJ/cm ²	145°C

Example 4.

A series of 10.16 cm (4") silicon wafers were coated with 2500Å AZ® BARLi™ coating on a MTI-Flexifab® coater and baked on a hot plate @ 170°C for 45 seconds. These BARLi™-coated wafers were further spin-coated to a resulting dry film thickness of approximately 1 μm (micrometers) with AZ®7200 positive tone photoresist, available from AZ® Photoresist Products, Hoechst Celanese Corporation,

Somerville, NJ. This photoresist contains a novolak resin and a mixture of 2,1,5- and 2,1,4-diazonaphthoquinone sulfonate ester photosensitizers, where one of the diazonaphthoquinone sensitizer is based on a trishydroxybenzophenone (TOB) ballast compound; it uses PGMEA as the resist casting solvent. The resist was coated to a thickness of 1.07 μm (micrometers) both on the BARLi-coated wafers and on bare silicon wafers. The wafers then were soft baked on a hot plate at a temperature at 110°C for 60 seconds for wafers #4A and #4B, and to 140°C for 10 seconds for wafer #4C, as indicated in Table 4. The baked wafers were then imagewise exposed with a NIKON® 0.54 NA i-line stepper using a reticle containing equal line&space patterns with linewidths from 0.2 μm (micrometers) to 1.0 μm (micrometers). The exposed wafers were developed with AZ® 300MIF developer (a 2.38% tetramethyl ammonium hydroxide solution in water) for a times given in Table 4. The linewidths of the developed resist line&space patterns were then measured with a HITACHI® S-4000 scanning electron microscope.

Table 4 compares the resist performance between the resist processed with and without BARLi™ antireflective coating to that of the resist processed with the flashbake process described in this invention.

Table 4.: Effect of Flashbake on AZ®7200 photoresist

Wafer #	on BARLi™ coating?	SB Temp.	PEB Temp.	Dev. Time	DTP	Resolution	DOF 0.45 μm l&zs
4A	No	110°C/60sec	110°C/60sec	52sec	65 mJ/cm ²	0.40 μm	0.8 μm
4B	Yes	110°C/60sec	None	52sec	90 mJ/cm ²	0.36 μm	1.0 μm
4C	Yes	140°C/10sec	None	90sec	100 mJ/cm ²	0.36 μm	1.2 μm

The results shown in Table 4 again indicate that the application of the flashbake process yields better resist performance (wafer #4C) than those processed with a conventional SB process with or without BARLi™ coating (wafer# 4A and

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5 #4B). As already seen in Example 1, application of the BARLi™ coating improved the resist performance over those on bare silicon substrate, with the flashbake process providing further performance improvement. The performance gain by the flashbake process, while noticeable and experimentally verifiable, is not as large for this photoresist which contains a thermally less stable tris-hydroxybenzophenone-based diazonaphthoquinone as is the gain described in Example 1 for the non-benzophenone based, more thermally stable AZ®7800 photoresist.

CLAIMS

THIS SHEET HAS BEEN REPLACED

1. A process for preparing a relief image on a substrate which comprises coating a photoresist on a substrate, baking the photoresist coating, and exposing the photoresist to actinic light, and treating the coated substrate to develop the image on said substrate, said bake step being carried out by bringing the substrate into contact or close proximity with a heated surface not lower in temperature than 130°C, for a period of no longer than 30 seconds.
2. The process of Claim 1, in which the temperature of the heated surface is between 130 to 160°C.
3. The process of Claim 1, in which the temperature of the heated surface is between 140 to 150°C.
4. The process of Claim 1, in which the baking time is lower than 21 seconds.
5. The process of Claim 1, in which the baking time is between 10 and 20 seconds.
6. The process of Claim 1, in which the photoresist is a diazonaphthoquinone/novolak resist.
7. The process of Claim 6, and the diazonaphthoquinone sensitizer has a backbone which is an aromatic compound but not a derivative of benzophenone.
8. The process of Claim 7, in which the aromatic compound has not more than one hydroxy group on any phenyl ring.

This Sheet Has Been Replaced





9. The process of Claim 6, wherein the photoresist contains a novolak resin and the novolak resin has undergone a process in which the low molecular weight components thereof have been partially or completely removed.
10. The process of Claim 9, in which the photoresist contains a monomeric compound or low molecular weight compound which increases the light sensitivity.
11. The process of Claim 1, in which the substrate is of low reflectivity, said low reflectivity preferentially being caused by an antireflective coating on the substrate.
12. The process of Claim 11, in which the antireflective coating is an inorganic absorbing or transparent material, where the transparent material is preferentially silicon oxide, and the absorbing material is preferentially silicon or titanium nitride.
13. The process of Claim 11, where the antireflective coating is an organic material which is removed in an imagewise way either in the process of developing the photoresist, or in a dry etch process.
14. The process of Claim 13, in which the antireflective layer is a dyed material with an absorptivity greater than $2 \mu\text{m}^{-1}$, most preferentially with an absorptivity of greater than $8 \mu\text{m}^{-1}$.

CLAIMS

[, without the intermediary of a second bake step at a temperature equal to or greater than the first bake step,

1. A process for preparing a relief image on a substrate which comprises coating a photoresist on a substrate, baking the photoresist coating, and exposing the photoresist to actinic light, and treating the coated substrate to develop the image on said substrate, said bake step being carried out by bringing the substrate into contact or close proximity with a heated surface not lower in temperature than 130°C, for a period of no longer than 30 seconds.
2. The process of Claim 1, in which the temperature of the heated surface is between 130 to 160°C.
3. The process of Claim 1, in which the temperature of the heated surface is between 140 to 150°C.
4. The process of Claim 1, in which the baking time is lower than 21 seconds.
5. The process of Claim 1, in which the baking time is between 10 and 20 seconds.
6. The process of Claim 1, in which the photoresist is a diazonaphthoquinone/novolac resist.
7. The process of Claim 6, and the diazonaphthoquinone sensitizer has a backbone which is an aromatic compound but not a derivative of benzophenone.
8. The process of Claim 7, in which the aromatic compound has not more than one hydroxy group on any phenyl ring.

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(54) Title: THERMAL TREATMENT PROCESS OF POSITIVE PHOTORESIST COMPOSITION			
(57) Abstract A flash softbake process for a diazonaphthoquinone sulfonate ester-novolac positive photoresist is described which offers significant advantages. This process uses a higher than conventional soft-baking (SB) temperature ($\geq 130^\circ\text{C}$) and a very short baking time (≤ 30 seconds) of the resist, preferably over a bottom antireflective coating. It significantly improves the photoresist's resolution, process latitude, thermal deformation temperature, resist adhesion and plasma etch resistance. If a low reflectivity substrate or an antireflective coating is used, it also eliminates the need for a post exposure bake (PEB) step during the photolithographic process, without causing a severe standing wave effect.			