

Table 2A. Result of first experiments using (P(PHS/S/TBA)) Resin

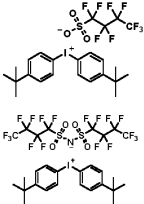
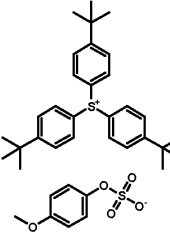
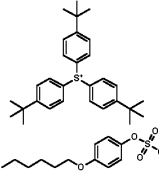
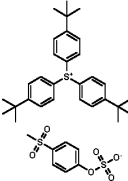
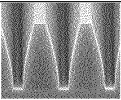
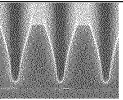
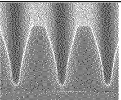
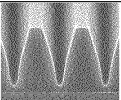
|                                     |                                                                                     |             |                                                                                     |                                                                                      |                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                     | (Ref.)<br>Example 1                                                                 | Comparative | Example 1                                                                           | Example 2                                                                            | Example 3                                                                             |
| PAG                                 | • Garo In-K<br>• ZK-0518                                                            |             | PAG P1                                                                              | PAG P2                                                                               | PAG P3                                                                                |
| PAG<br>structure                    |    |             |    |    |    |
| PAG (mmol)                          | 2.16                                                                                |             | 2.16                                                                                | 2.16                                                                                 | 2.16                                                                                  |
| PAG/Acid<br>quencher<br>molar ratio | 2.5                                                                                 |             |                                                                                     |                                                                                      |                                                                                       |
| Sens.<br>@1μm<br>Trench             | 190mJ/cm <sup>2</sup>                                                               |             | >350mJ/cm <sup>2</sup>                                                              | >350mJ/cm <sup>2</sup>                                                               | >350mJ/cm <sup>2</sup>                                                                |
| Pattern<br>profile                  |  |             |  |  |  |

FIG. 1

Table 2B. Result of first experiments using (P(PHS/S/TBA)) Resin

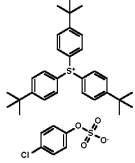
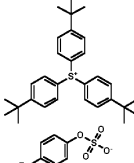
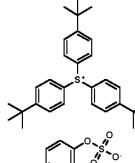
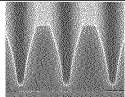
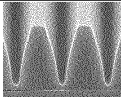
|                               |                                                                                    |                                                                                    |                                                                                     |
|-------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                               | Example 4                                                                          | Example 5                                                                          | Example 6                                                                           |
| PAG                           | PAG P4                                                                             | PAG P5                                                                             | PAG P6                                                                              |
| PAG structure                 |   |   |  |
| PAG (mmol)                    | 2.1                                                                                | 2.1                                                                                | 2.1                                                                                 |
| PAG/Acid quencher molar ratio | 2.5                                                                                | 2.5                                                                                | 2.5                                                                                 |
| Sens. @1μm Trench             | >350mJ/cm <sup>2</sup>                                                             | >350mJ/cm <sup>2</sup>                                                             | >350mJ/cm <sup>2</sup>                                                              |
| Pattern profile               |  |  | No image                                                                            |

FIG. 2

Table 3A. Result of second experiments using (P(PHS/S/TBA)) Resin  
(Decrease an acid quencher amount)

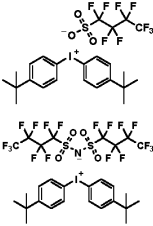
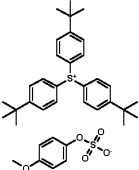
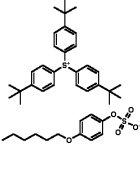
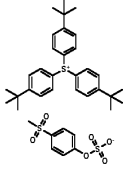
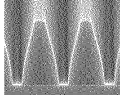
|                                     |                                                                                     |                                                                                     |                                                                                      |                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                     | (Ref.)<br>Comparative<br>Example 2                                                  | Example 7                                                                           | Example 8                                                                            | Example 9                                                                             |
| PAG                                 | • Garo In-K<br>• ZK-0518                                                            | PAG P1                                                                              | PAG P2                                                                               | PAG P3                                                                                |
| PAG structure                       |    |    |    |    |
| PAG (mmol)                          | 2.1                                                                                 | 2.1                                                                                 | 2.1                                                                                  | 2.1                                                                                   |
| PAG/Acid<br>quencher molar<br>ratio | 9.7                                                                                 | 9.7                                                                                 | 9.7                                                                                  | 9.7                                                                                   |
| TBA/PAG<br>Molar Ratio              | 86                                                                                  | 86                                                                                  | 86                                                                                   | 86                                                                                    |
| Sens.<br>@1μm Trench                | 151mJ/cm <sup>2</sup>                                                               | 194mJ/cm <sup>2</sup>                                                               | 186mJ/cm <sup>2</sup>                                                                | 191mJ/cm <sup>2</sup>                                                                 |
| Pattern<br>profile                  |  |  |  |  |

FIG. 3

Table 3B. Result of second experiments using (P(PHS/S/TBA)) Resin  
(Decrease an acid quencher amount)

|                               |                       |                       |                       |
|-------------------------------|-----------------------|-----------------------|-----------------------|
|                               | Example 10            | Example 11            | Example 12            |
| PAG                           | PAG P4                | PAG P5                | PAG P6                |
| PAG structure                 |                       |                       |                       |
| PAG (mmol)                    | 2.1                   | 2.1                   | 2.1                   |
| PAG/Acid quencher molar ratio | 9.7                   | 9.7                   | 9.7                   |
| TBA/PAG Molar Ratio           | 86                    | 86                    | 86                    |
| Sens. @1μm Trench             | 180mJ/cm <sup>2</sup> | 181mJ/cm <sup>2</sup> | 267mJ/cm <sup>2</sup> |
| Pattern profile               |                       |                       |                       |

FIG. 4

Table 4A. Result of third experiments using P(PHS/S/TBA) Resin  
(Change cation unit of aryl onium aryl sulfate PAGs)

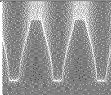
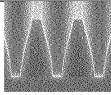
|                                  | (Ref.) Comparative<br>Example 2                                                     | Example 13                                                                          | Example 14                                                                           | Example 15                                                                            |
|----------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| PAG                              | • Garo In-K<br>• ZK-0518                                                            | PAG P7                                                                              | PAG P8                                                                               | PAG P9                                                                                |
| PAG structure                    |                                                                                     |                                                                                     |                                                                                      |                                                                                       |
| PAG (mmol)                       | 2.1                                                                                 | 2.1                                                                                 | 2.1                                                                                  | 2.1                                                                                   |
| PAG/Acid quencher<br>molar ratio | 9.7                                                                                 | 9.7                                                                                 | 9.7                                                                                  | 9.7                                                                                   |
| TBA/PAG Molar<br>Ratio           | 86                                                                                  | 86                                                                                  | 86                                                                                   | 86                                                                                    |
| Sens.@1μm Trench                 | 168mJ/cm <sup>2</sup>                                                               | 115mJ/cm <sup>2</sup>                                                               | 111mJ/cm <sup>2</sup>                                                                | 155mJ/cm <sup>2</sup>                                                                 |
| Pattern<br>profile               |  |  |  |  |

FIG. 5

Table 4B. Result of third experiments using P(PHS/S/TBA) Resin  
(Change cation unit of aryl onium aryl sulfate PAGs)

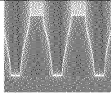
|                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                      |                                                                                       |
|-------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                     | Example 16                                                                          | Example 17                                                                          | Example 18                                                                          | Example 19                                                                           | Example 20                                                                            |
| PAG                                 | PAG P10                                                                             | PAG P14                                                                             | PAG P11                                                                             | PAG P12                                                                              | PAG P13                                                                               |
| PAG structure                       |                                                                                     |                                                                                     |                                                                                     |                                                                                      |                                                                                       |
| PAG (mmol)                          | 2.1                                                                                 | 2.1                                                                                 | 2.1                                                                                 | 2.1                                                                                  | 2.1                                                                                   |
| PAG/Acid<br>quencher<br>molar ratio | 9.7                                                                                 | 9.7                                                                                 | 9.7                                                                                 | 9.7                                                                                  | 9.7                                                                                   |
| TBA/PAG<br>Molar Ratio              | 86                                                                                  | 86                                                                                  | 86                                                                                  | 86                                                                                   | 86                                                                                    |
| Sens.@1μm<br>Trench                 | 110mJ/cm <sup>2</sup>                                                               | 113mJ/cm <sup>2</sup>                                                               | 79mJ/cm <sup>2</sup>                                                                | 44mJ/cm <sup>2</sup>                                                                 | 82mJ/cm <sup>2</sup>                                                                  |
| Pattern<br>profile                  |  |  |  |  |  |

FIG. 6

Table 5. Lithographic performance in P(PHS/PTBST/TBA) Resin

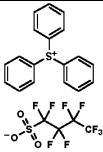
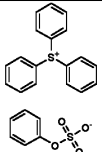
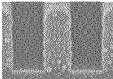
|                                   | (Ref.) Comparative Example 4                                                       | Example 21                                                                          |
|-----------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| PAG                               | TPS-Nona                                                                           | PAG P7                                                                              |
| PAG structure                     |   |   |
| PAG (mmol)                        | 0.6                                                                                | 0.6                                                                                 |
| PAG/Triethanol molar ratio        | 4.8                                                                                | 4.8                                                                                 |
| PAG/TPSA molar ratio              | 2.3                                                                                | 2.3                                                                                 |
| PAG/dimethylacetamide molar ratio | 0.11                                                                               | 0.11                                                                                |
| (TBA+PTBST)/PAG Molar Ratio       | 48                                                                                 | 48                                                                                  |
| Eo                                | 49mJ/cm <sup>2</sup>                                                               | 44mJ/cm <sup>2</sup>                                                                |
| Pattern profile                   |  |  |

FIG. 7

Table 6A. Lithographic performance in P(EEOST/PHS) Resin

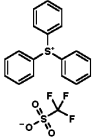
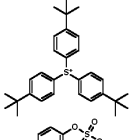
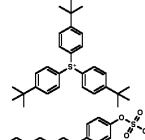
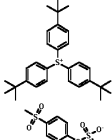
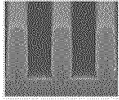
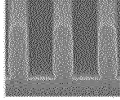
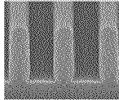
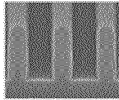
|                                            | Comparative<br>Example 5                                                            | Example 22                                                                          | Example 23                                                                           | Example 24                                                                            |
|--------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| PAG                                        | TPS Tf                                                                              | PAG P1                                                                              | PAG P2                                                                               | PAG P3                                                                                |
| PAG structure                              |    |    |    |    |
| PAG TPS Tf or aryl sulfate (mmol)          | 0.485                                                                               | 0.485                                                                               | 0.485                                                                                | 0.485                                                                                 |
| PAG (Tf or aryl sulfate)/BCHSD Molar ratio | 0.0324                                                                              | 0.0324                                                                              | 0.0324                                                                               | 0.0324                                                                                |
| EEOST/PAG (BCHSD)                          | 16.1                                                                                | 16.1                                                                                | 16.1                                                                                 | 16.1                                                                                  |
| PAG (Tf or aryl sulfate)/DCHMA Molar ratio | 1.98                                                                                | 1.98                                                                                | 1.98                                                                                 | 1.98                                                                                  |
| PAG (Tf or aryl sulfate)/TPSA Molar ratio  | 1.67                                                                                | 1.67                                                                                | 1.67                                                                                 | 1.67                                                                                  |
| PAG (Tf or aryl sulfate)/DMA Molar ratio   | 0.011                                                                               | 0.011                                                                               | 0.011                                                                                | 0.011                                                                                 |
| Eo                                         | 18.8mJ/cm <sup>2</sup>                                                              | 21.1mJ/cm <sup>2</sup>                                                              | 21.0mJ/cm <sup>2</sup>                                                               | 21.1mJ/cm <sup>2</sup>                                                                |
| Pattern profile                            |  |  |  |  |
| Linearity                                  | 180nm~                                                                              | 190nm~                                                                              | 190nm~                                                                               | 190nm~                                                                                |
| EL (CD±10%)                                | 22.0%                                                                               | 25.1%                                                                               | 23.5%                                                                                | 22.4%                                                                                 |
| DOF(CD±10%)                                | 1.0μm                                                                               | 1.0μm                                                                               | 0.8μm                                                                                | 0.8μm                                                                                 |

FIG. 8

Table 6B. Lithographic performance in (EEOST/PHS) resin

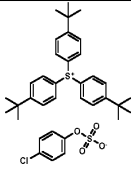
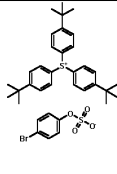
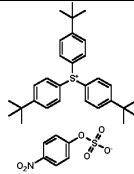
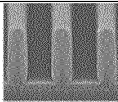
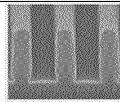
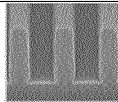
|                                      |                                                                                     |                                                                                      |                                                                                       |
|--------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                      | Example 25                                                                          | Example 26                                                                           | Example 27                                                                            |
| PAG                                  | PAG P4                                                                              | PAG P5                                                                               | PAG P6                                                                                |
| PAG structure                        |    |    |    |
| PAG aryl sulfate (mmol)              | 0.485                                                                               | 0.485                                                                                | 0.485                                                                                 |
| Molar ratio PAG (aryl sulfate)/BCHSD | 0.0324                                                                              | 0.0324                                                                               | 0.0324                                                                                |
| EEOST/PAG (BCHSD)                    | 16.1                                                                                | 16.1                                                                                 | 16.1                                                                                  |
| PAG (aryl sulfate)/DCHMA Molar ratio | 1.98                                                                                | 1.98                                                                                 | 1.98                                                                                  |
| Molar ratio PAG (aryl sulfate)/TPSA  | 1.67                                                                                | 1.67                                                                                 | 1.67                                                                                  |
| PAG (aryl sulfate)/DMA Molar ratio   | 0.011                                                                               | 0.011                                                                                | 0.011                                                                                 |
| Eo                                   | 21.1mJ/cm <sup>2</sup>                                                              | 20.7mJ/cm <sup>2</sup>                                                               | 21.7mJ/cm <sup>2</sup>                                                                |
| Pattern profile                      |  |  |  |
| Linearity                            | 190nm~                                                                              | 190nm~                                                                               | 190nm~                                                                                |
| EL (CD±10%)                          | 23.0%                                                                               | 22.5%                                                                                | 23.0%                                                                                 |
| DOF (CD±10%)                         | 0.8μm                                                                               | 1.0μm                                                                                | 1.0μm                                                                                 |

FIG. 9

Table 7. Dose-to-print values in (PHS/S/TBA) resin

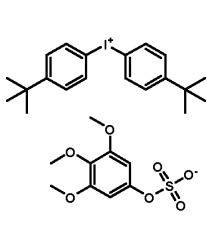
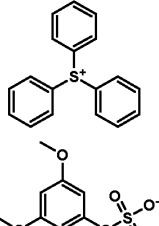
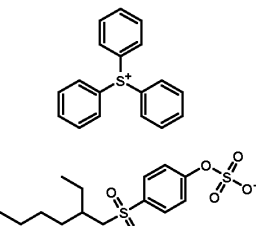
|                        |                                                                                   |                                                                                   |                                                                                    |
|------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|                        | Example 28                                                                        | Example 29                                                                        | Example 30                                                                         |
| PAG                    | PAG P18                                                                           | PAG P15                                                                           | PAG P16                                                                            |
| PAG structure          |  |  |  |
| Dose to print (mJ/cm²) | 3.4                                                                               | 4.1                                                                               | 4.5                                                                                |

FIG. 10