Conductive layer for the e-beam lithography for all kinds of e-beam resists

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A high resolution and precise structuring with e-beam lithography is only to a very limited extent possible without additional process steps on insulating substrates like quartz, glass, and III/V semiconductors (e.g. GaAs) [1], [2], [3]. When writing with electrons, the substrate is electrically charged due to its insulating properties because the charge cannot be dissipated. As a result, only strongly distorted patterns are obtained since the electron beam is deflected in an uncontrolled manner during the scanning of structures. The evaporation of a thin layer of metal prevents this effect, is however time-consuming and expensive. Commercially available conductive layers (1) which are applied by spin coating are associated with certain disadvantages (short shelf life, difficult to remove after exposure, high costs).

We were now able to develop the water-based, conductive coating Electra 92 which can be applied onto all e-beam resists investigated (2) without any problems. After electron beam irradiation, the conductive layer can be removed residue-free with water. Even at high exposure doses up to 5000 µC/cm² (e.g. HSQ-resist), no crosslinking occurs. Performance characteristics remain constant for at least 6 month; respective results for one year will be available on the MNE 2015.

The conductivity of the layer was determined according to the following procedure: Ridges with different width were produced between two electrodes and the electrical resistance was measured (Fig. 2). In Fig. 1, a temperature dependence of the conductivity under room conditions becomes apparent. A tempering at 190 °C results in a considerable reduction in conductivity. Air humidity similarly decreases the conductivity. Work is currently in progress to measure the conductivity under real application conditions (high vacuum, no air moisture, electrical field during exposure).

Application examples: The article demonstrates the fabrication of a 21-nm HSQ-structure on quartz and furthermore reports on a two-layer PMMA system on quartz for lift-off processes. Presented is also the application of Electra on e-beam resist CSAR for very high resolutions.

Using a two-layer system, also a fabrication of directly conductive structures is possible. A layer of Electra is in this case coated with a solvent developable e-beam resist or photoresist. The resist is subsequently structured and the conductive layer is removed in the free areas with an aqueous alcoholic developer. The photoresists is finally removed with acetone, while the conductive structure remains.

Final results will be presented on the MNE 2015.

(1) Spacer, SX AR-PC 5000/90.1

(2) PMMA, CSAR 62, ZEP 520A, FEP 171, AR-N 7520, HSQ