HSQ application for sub-10 nm scale lithography

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An application of hydrogen silsesquioxane (HSQ) negative tone electron beam resist for a sub-10 nanometer scale fabrication is reported. Flowable Oxide resist solutions in methyl isobutyl ketone (MIBK) (FOx-12, Dow Corning) was further diluted with MIBK and spun over silicon wafers. Spin-coated films were prebaked for 5 min at 180°C. Characterisation of the resist was carried out. The resist surface roughness after the prebake process was better than 2nm over a 20μm square area measured by an atomic fofce microscopy (AFM). After e-beam irradiation resist was developed in MF322 (Shipley) for 60 s, and then rinse in deionized water for 15 s and blown dry with N_2. The measurements of the sensitivity, contrast and etching durability follow. The threshold of the sensitivity about 600 μC/cm^2 was found, whereas the dose needed for proper generation of 40 nm lines is about 1300 μC/cm^2. We have found that about 13 fC is sufficient to develop properly dots with diameter of 20 nm. The influence of the e-beam source fluctuation on the control of the electron beam exposure is reported.

We have tested resist-etching durability to CF_4 plasma with 50 W rf power and 150 V dc bias. The etching rate was found about 2 nm/s which is six times better then that of Si and twenty four times better than that of polymethylmethacrylat (PMMA). The measured durability is even better than that of highly durable novolak resists as SAL, ZEP and AZ.

To minimize forward electron scattering effect, while keeping necessary masking properties of the resist, we have chosen 40 nm as a necessary resist thickness. There will be a communication on initial results from investigations of ultimate resolution and plausibility of HSQ application for neuromorphic networks based on molecular single electron domain experiments. Extremely dense neuromorphic networks may be based on hybrid 2D arrays of nanoscale components, including molecular latching switches working as adaptive synapses, nanowires as axons and dendrites, and nano-CMOS circuits serving as neural cell bodies.

The recent demonstration of first single-molecule single-electron transistors offers hope for the development, within the next decade or so, of *CMOL* integrated circuits with density beyond 10^{12} functions per sqcm. Tests are done with JEOL's EBL system JBX-9300FS.

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