Enhanced Stability of Hydrogen Silsesquioxane (HSQ) through Stabilizer-Incorporated Variant

H. Biller,[a] Dr. M. Gerngross,[a] Dr. M. Sendel,[a] M. Schirmer,[a] F. Heyroth,[b]

[a] *Allresist GmbH, Strausberg, 15344 Germany*

[b] *Interdisciplinary Center of Materials Science (CMAT), Martin-Luther-University, Halle-Wittenberg, 06120 Germany*

harry.biller@allresist.de

Hydrogen Silsesquioxane (HSQ) has emerged as a versatile material in various microfabrication processes due to its unique properties, including high thermal stability and excellent dielectric characteristics. However, its susceptibility to degradation over time has been a limiting factor in its widespread application. To overcome this problem, Allresist GmbH introduces Medusa 84 SiH, a new iteration of the purely inorganic HSQ $[HSiO_{3/2}]_n$. This innovative variant prevents the reactive Si-H in the material from degrading by incorporating a stabilizer, resulting in a significant extension of the product's shelf life as a liquid e-beam resist.

Different types of stabilizers were screened based on its compatibility with HSQ and its ability to mitigate degradation processes. Characterization techniques, including Fourier-transform infrared spectroscopy (FTIR) and thermal analysis, confirmed the impact of the stabilizer on the storage stability of the Medusa 84 SiH.

Accelerated aging tests conducted over a 30-day period at 40°C showcased a significant enhancement in the stability of Medusa 84 SiH featuring a mere 0.25% stabilizer content relative to the mass of HSQ dissolved in butyl acetate. The Medusa 82 SiH showed no signs of commonly associated degradation phenomena like particle growth or gelation.

In contrast to the conventional HSQ, the incorporation of the stabilizer led to a notable enhancement in sensitivity. This improvement was quantified by achieving a D/D_o of 0.9 at 230 µC/cm² using 30 kV ebeam and a 6.25% TMAH developer (Figure 1).

For insulating substrates, Allresist GmbH has developed a modified version of the conductive resist Electra 92, especially adapted for use with Medusa 84 SiH. This adaptation ensures reliable adhesion to the highly hydrophobic surface of Medusa 84 SiH, allowing highest resolution, especially on insulating substrates such as quartz (Figure 2).

Allresist GmbH offers the new Medusa 84 SiH and Electra 92 products directly and through sales partners to interested users in the academic and industrial field. The extended shelf life guarantees consistent quality even during prolonged transportation, eliminating the need for freezer storage.

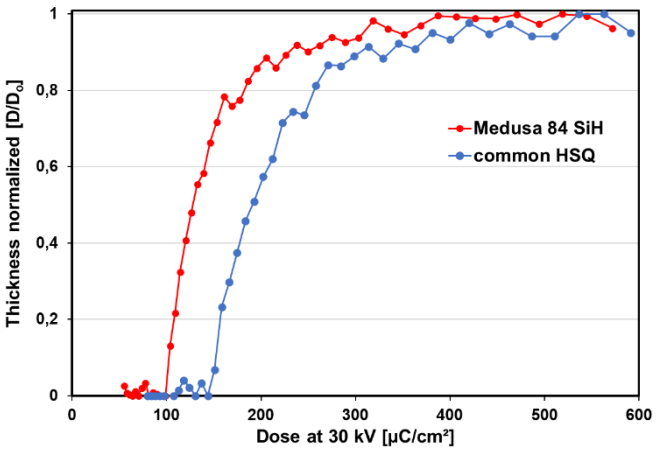

Figure 1: Contrast curves of Medusa 84 SiH in comparison of common HSQ, dev: TMAH 6.5% 90s, stop: 60 s H_2O.

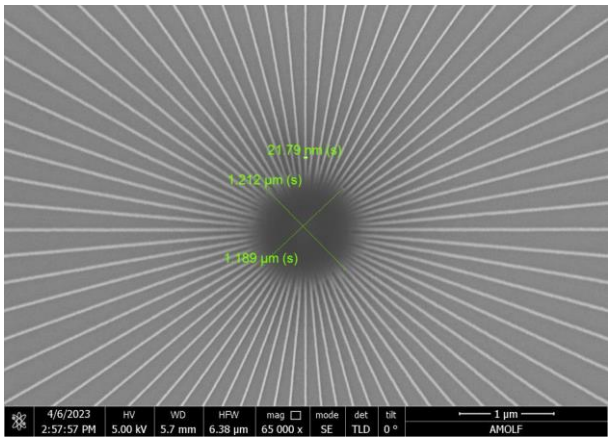

Figure 2: Lines of the Siemens star generated up to 22 nm wide using AR-PC 5092.02 on HSQ.
© Bob Drent, AMOLF NanoLab Amsterdam

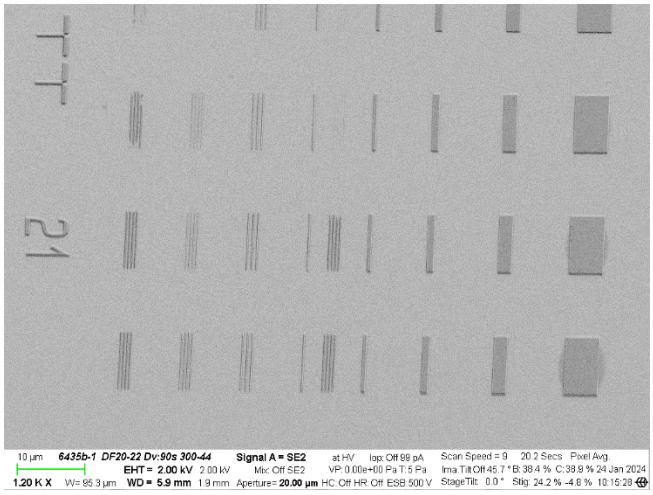

Figure 3: Dosis tests of Medusa 84 SiH on silica substrate, dev: TMAH 2.38% 90s, stop: 60 s H_2O.
© Frank Heyroth, CMAT Halle-Wittenberg