



AR NEWS

38th Issue, October 2018, Allresist GmbH



Content:

- 1. 26 years of Allresist - Inauguration of the new plant on the company anniversary**
- 2. Allresist's great success with Medusa 82 at the MNE 2018**
- 3. Further Allresist highlights at the MNE**
- 4. Atlas 46 and CAR 44 for e-beam lithography**
- 5. Phoenix 81 – World-wide sales begin!**
- 6. Offspring at Allresist – The next generation!**

Welcome to the 38th issue of our AR NEWS. Once again, we would like to inform you about the further development of our company and the current research projects.

1. 26 years of Allresist - Inauguration of the new plant on the company anniversary

The intensive years of product development and their transfer to production have paid off. Just in time for our 26th anniversary, the new 450 m² annex including a production expansion is ready for operation. This busy, but also joyful time lies now behind us. To see how the company gradually grows and to know that we will from now on benefit from the great opportunities which emerge, makes us proud.

Our raw material will now be synthesized efficiently, environmentally friendly and in highest quality in the extended production tract. The 200 litre reactor "Frida" is used for the synthesis of raw material like e.g. the copolymer required for AR-P 617, while CSAR 62 is synthesized in two reactor boxes. The flagship of the production will be the new 1,000 litre batch container "Goliath" which perfectly meets the increasing demands of our large customers.



Fig. 1 New delivery entrance

In the meantime, also a 300 m² green roof was installed next to the photovoltaic system on the new building. In spring, when the perennials grow and become a carpet, the roof will provide habitat for birds and insects, filter air pollutants and save energy in the building due to an improved thermal insulation. In addition, the green roof increases the efficiency of the adjacent photovoltaic system and thus helps to save approximately 21 tonnes of climate-damaging CO₂ emissions every year. Allresist uses a large part of the clean electricity for the production (which doubled since 2013).



Fig. 2 Green roof (with photovoltaic system in the background)

We would like to express our special thanks to the state of Brandenburg for the helpful GRW funding. With this support, all desired investments could be realized without delay.



We are happy to say that the quite demanding expansion of the company building has been successfully completed without delivery delays for our customers.



Fig. 3 Brigitte and Matthias Schirmer in front of the synthesis reactor in the new production wing (photo by Stephan Dreys)

2. Allresist's great success with Medusa 82 at the MNE 2018

This year's MNE Conference took place in Copenhagen. Allresist participated with a large, attractive stand and new innovations.



Fig. 4 Allresist research team at the MNE 2018 Conference

As already in previous years, the interest of the conference participants in our diverse new developments was great. Absolute highlight however was the presentation of Medusa 82, our excellent alternative to HSQ resists. Dr. Tobias Mai outlined in his talk the significantly better properties of Medusa 82 like for example the higher process stability and sensitivity.

If used for standard processing, HSQ and Medusa are nearly identical with respect to sensitivity and resolution.

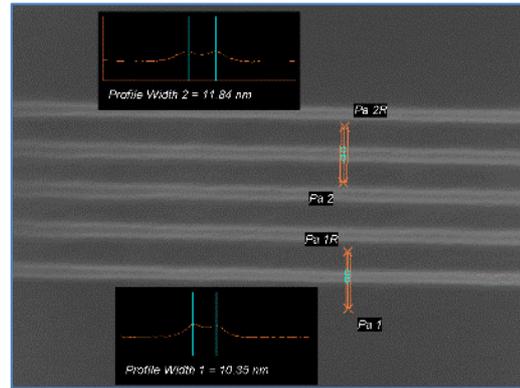


Fig. 5 11 nm lines in Medusa 82, 1,250 $\mu\text{C}/\text{cm}^2$, 30 kV, @Raith GmbH

An impressive advantage of Medusa 82 (SX AR-N 8200) is its process stability. While the manufacturer of HSQ recommends fast processing within a few hours (since otherwise a reproducibility of results is not given), Medusa can be stored for at least three weeks after coating and irradiation and still guarantees reproducible results. In addition, the shelf life of the liquid resist SX AR-N 8200 is some orders of magnitude better. While HSQ must be stored under extreme cooling conditions (e.g. liquid nitrogen), Medusa only requires normal storage in a refrigerator to achieve a shelf life of at least 6 months.

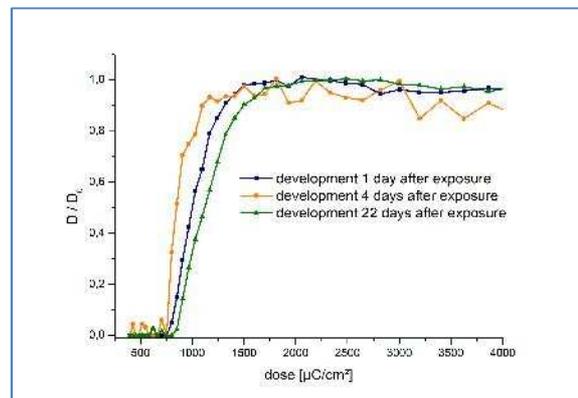


Fig. 6 Gradation curve of Medusa 82 after up to 22 days, @Martin-Luther-University, Halle (MLU)

The relatively low sensitivity of HSQ and Medusa is both advantage and disadvantage at the same time. On the one hand, long writing times are needed; on the other hand, the high number of required electrons ensures a very low edge roughness and a high resolution.

Medusa 82 and HSQ are both characterized by excellent plasma etch stability. The high silicon content of the polymers results in the formation of SiO_2 (sandstone in the broadest sense) during etching with oxygen plasma.

This process prompted us to name this resist "Medusa", in reminiscence of the Greek goddess whose mere sight turned everybody instantly into stone.



Fig. 7 Painting of Medusa by Carlos Schwabe, 1890

Many users would probably like to exploit the particularly high etch stability, but are on the other hand deterred by the long writing times. Two approaches are possible to circumvent this problem:

1. Modification of Medusa: Addition of an acid generator (PAG) surprisingly increases the sensitivity about 20-fold while concomitantly increasing the contrast. At an acceleration voltage of 100 kV, the sensitivity is quintupled (@KIT, Karlsruhe).

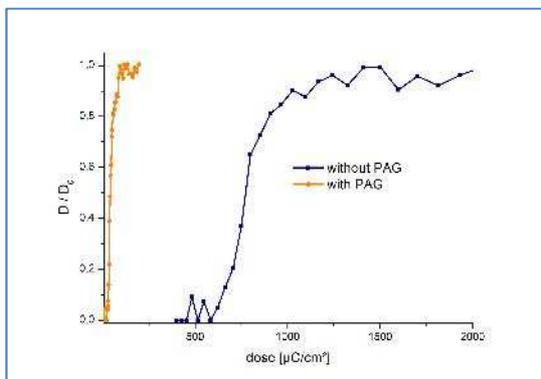


Fig. 8 Sensitivity increase at 30 kV @MLU

2. Tempering after exposure: It surprisingly turned out that, even without any addition of PAG, a tempering after the irradiation not only improves the contrast, but also considerably increases the sensitivity.

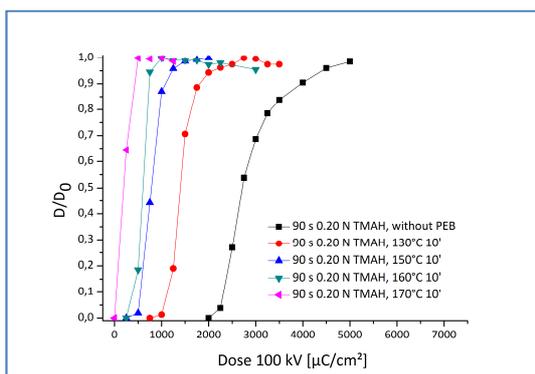


Fig. 9 Influence of tempering after irradiation @ KIT, Karlsruhe

In a joint project with the RWTH Aachen, Chair of Technology Optical Systems TOS, Medusa 82 was also tested with respect to its suitability for 13 nm EUV-lithography.

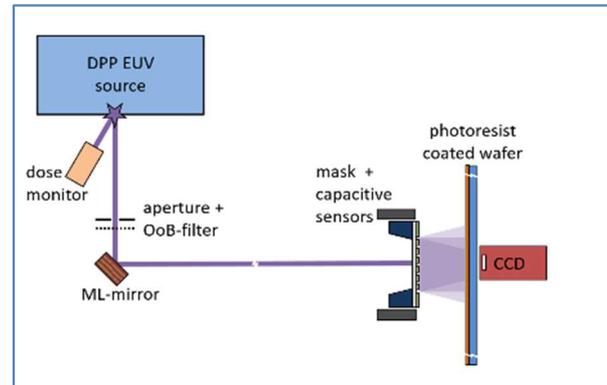


Fig. 10 Schematic diagram of the 13 nm EUV tool in Aachen

The Medusa sample with PAGs met the desired window of sensitivity of about 30 mJ/cm².

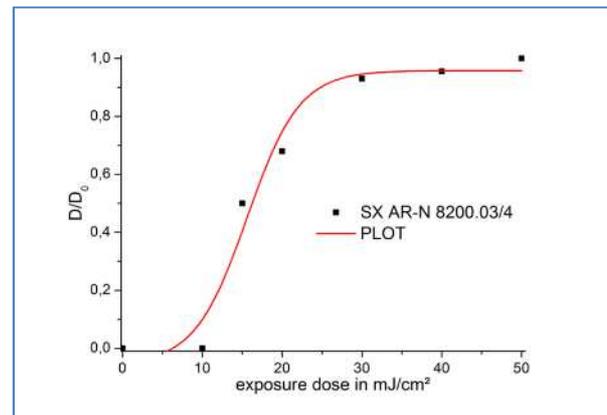


Fig. 11 EUV gradation curve (13 nm) with Medusa @ RWTH Aachen

To round off the broad spectrum of Medusa properties, also investigations aimed at use in "normal" photolithography are ongoing. Medusa 82 behaves like a standard negative photoresist at an exposure wavelength of 267 nm. Further approaches with broadband UV yielded the first promising results. We will gladly inform you as soon as well-founded data are available.

With Medusa 82, we currently establish a complex resist system that should be of great interest for many users. In joint efforts with our partners MLU (Halle), KIT (Karlsruhe) and Raith (Dortmund), we will quickly gather still outstanding process parameters and develop Medusa 82 to product maturity in the near future. Small test samples are already available in November 2018.

3. Further Allresist highlights at the MNE

On our exhibition stand, we showed the new developments of the last four years. The well-established CSAR 62 e-beam resist was not only presented with respect to its general properties, but also as part of a three-layer system for the precise production of T-gates. With a layer structure of PMMA (bottom)/AR-P 617 (middle)/CSAR 62 (top), resist structures for T-gates can be generated.

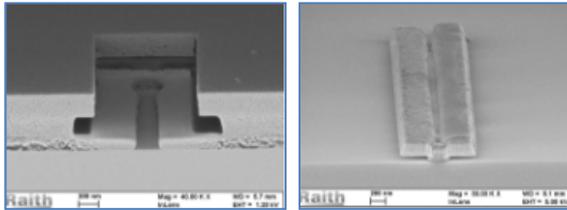


Fig. 12 Three-layer structure after development and finished T-gate

In addition to the structuring of e-beam resists on insulating substrates, many customers meanwhile use **Electra 92** for the production of scanning electron microscope (SEM) images. The conductivity of the thin Electra layer prevents a distorting sample surface charging during the scan process.

Much attention was also paid to our **fluorescent resists**. The structures can be illuminated by admixing fluorescent dyes or Q-dots to the resist.



Fig. 13 Fluorescent PMMA structures after by e-beam exposure

Also new is the protective coating **F-Protect**, an alternative to the well-known Cytop. The resists are used as dielectric or as protective layer on e.g. organic semiconductors and are characterized by high optical transparency and a low refractive index of about 1.35.

You will find more information on our website at www.allresist.de.

4. Atlas 46 and CAR 44 for e-beam lithography

Atlas 46 has already been extensively reported on in recent AR NEWS issues. Another new field of applications is electron beam lithography. A thin resist layer was patterned by e-beam lithography. 200 nm lines were written into the layer of approx. 450 nm (a commonly used film thickness for e-beam resists). The sensitivity was around 70 $\mu\text{C}/\text{cm}^2$ at an acceleration voltage of about 100 kV. The development was carried out with AR 300-12, followed by short aftertreatment with acetone.

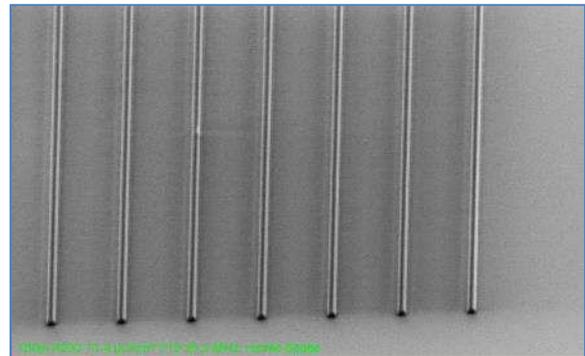


Fig. 14 200 nm lines produced with Atlas

The results of CAR 44 (AR-N 4400-10) were even more spectacular for layers with a thickness of 9.5 μm . The 2 μm wide webs shown in Fig. 15 were written at a dose of about 40 $\mu\text{C}/\text{cm}^2$ (100 kV) and developed with developer AR 300-26.

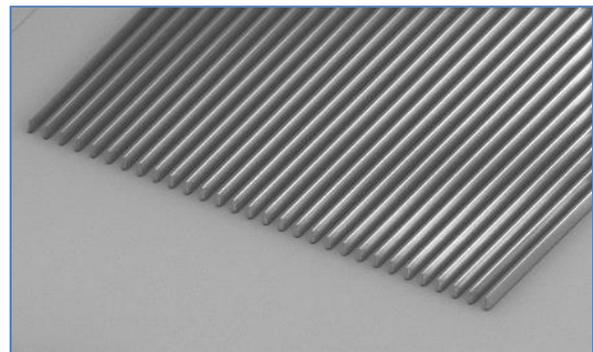


Fig. 15 2 μm webs with a height of 9,5 μm produced by e-beam lithography

Atlas 46 and CAR 44 are thus also suitable for a use as electron beam resists.

5. Phoenix 81 – World-wide sales begin!

At the MNE, the distribution options of Phoenix 81 as a resist for the NanoFrazor were discussed together with the SwissLitho AG (Heidelberg Instruments AG). If Phoenix 81 is used for NanoFrazor technologies, the resist layer

disintegrates upon contact with the very hot needle and evaporates.

This thermal instability is unfortunately also reflected by the limited shelf life of resist solutions. A stability of for more than 6 months is only given if a storage temperature of -18 °C is continuously maintained. The transport to the customer thus has to be carried out under strict cooling, which demands a complex logistics and is thus very expensive.

Stability studies conducted with the solid Phoenix polymer demonstrated that storage for up to 6 days at 35 °C has no effect on the quality of the powder. Resists produced from the powder stored for 6 days yielded the same results as achieved before. The powder thus tolerates a transport under normal conditions without additional cooling without damage.

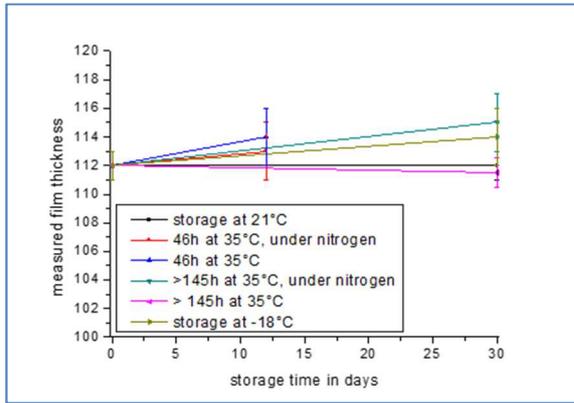


Fig. 16 Film thickness check after thermal stress

We thus offer Phoenix 81 in packages of 1 g of powder or as kit comprising 1 g of powder, 250 ml resist solvent and a syringe with filter.

Customers can then adjust the desired layer thickness with the resist solvent according to own needs. All required instructions are described in detail in the respective product information.

Further information is available at www.swisslitho.ch and www.allresist.de.

6. Offspring at Allresist – The next generation!

Ulrike Schirmer, daughter of the CEOs and future successor, gave birth to her son Aaron Stephan Schirmer on 03.08.2018. This will secure the future of Allresist for another generation 😊!



Fig. 17 Ulrike and Aaron

We hope that you found interesting topics or new ideas and appreciate your feedback.

The next regular issue of the AR NEWS will again be presented in April 2019.

Until then, we wish you and us successful times!



Strausberg, 16th October 2018

Matthias & Brigitte Schirmer in the Allresist Team