AR NEWS

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Welcome to the 31st issue of AR NEWS. Once again, we would like to inform you about the further development of the company and our research projects.

1. Innovative new developments presented on the MNE 2015 and the SEMICON Europe: A case for two – CSAR 62 & Electra 92

Allresist presented with geat public attention the two new developents CSAR 62 and Electra 92 on the MNE (Micro and Nano Engineering) in The Hague in September 2015 and on the SEMICON Europe in Dresden in October.

For excellent results in electron beam lithography on glass or other insulating substrates, the interplay between both resists is indispensible – simply a case for two – and many visitors to our exhibition booths were impressed with the recent results concerning this perfect match. Both events turned out to be very successful for us and in many respects reflect our current financial year. Our sales volumes has increased further, at an export share of meanwhile 39 %. Two important scientific projects are still in progress; three further projects are shortly before approval. The hot summer in addition brought us high electrical power yields from our new photovoltaic system with monthly energy feeds of 3500 kWh into the public grid.

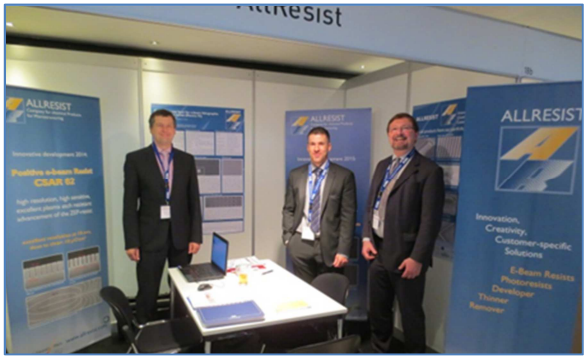

Fig. 1: Allresist exhibition booth on the MNE in The Hague

2. Alternative to Ecpacer Electra 92 meets user expectations

2.1 Long shelf life of Electra 92

A long product shelf life is always important for users. To assess the storage stability, two Electra batches were subjected to conductivity measurements after different storage times (15 months and 3 months, respectively). The studies demonstrated that the determined conductivities of both samples on quartz are almost identical up to 100 °C. These results indicate a constant conductivity and thus a high storage stability even after 15 months of storage.

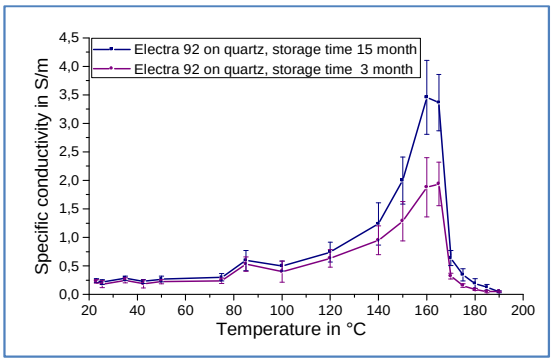

Fig. 2: Conductivity properties of Electra 92 batches stored for different times

Interesting to note is also that raising the temperature to more than 160 °C leads to a drastic increase in conductivity. This increase is mainly caused by the removal of water from the resist layer. After cooling to room temperature, the conductivity decreases again within several hours which can be explained by a reabsorption of water from the humidity in the air. If the layer is heated to more than 165 °C and thus the decomposition temperature is reached, the conductivity decreases abruptly and irreversibly.

2.2 CSAR structures on glass, made possible due to Electra 92

The use of a combination of CSAR 62 and the conductive coating Electra 92 in e-beam lithography allows the manufacture of highly complex structures on insulating glass or semi-insulating substrates such as e.g. gallium arsenide. The very high sensitivity and excellent resolution of CSAR 62 are harmoniously complemented by the good conductive properties of Electra 92.

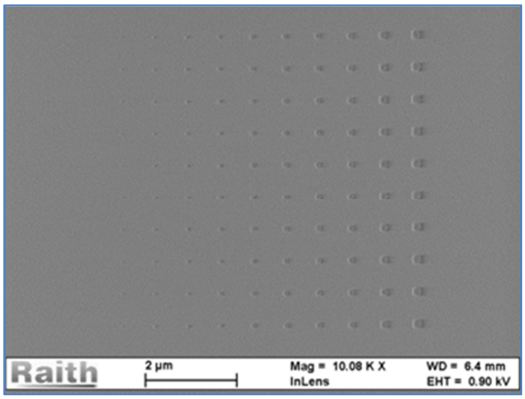

Fig. 3: 30 – 150 nm squares of CSAR 62 on glass, supported by Electra 92 (SX AR-PC 5000/90.2)

The process parameters are listed in detail in the product description of Electra 92 and can be accessed at any time.

2.3 PMMA lift-off structures on semi-precious stone substrates with Electra 92

Semi-precious stones like sapphire or garnet increasingly gain in importance as substrates for semiconductor industry. Even though these materials have insulating properties, a patterning with electron beam lithography is nevertheless possible with the help of Electra 92. Mr. Chi Tang in the working group of Prof. Jing Shi at the University of California has been working with Electra 92 since six months. His special field of work is the coating of PMMA on semi-precious stones such as garnet in PMMA two-layer processes. Since he has started to work with SX AR-PC 5000/90.2, he is able to easily process his lift-off structures with the two-layer system.

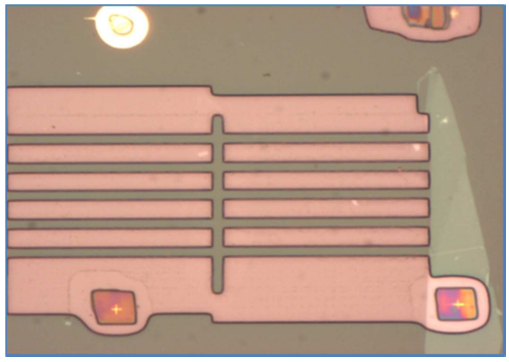

Fig. 4: Lift-off structures on garnet, supported by Electra 92

All in all, a lot of praise came from our users who confirm that Electra 92 is at least equivalent to Espacer with respect to its specific properties. The adhesion features are even better, as the example of HSQ shows, and Electra 92 has furthermore a significantly longer shelf life. Another advantage is the price: Electra 92 is currently approximately 4 times cheaper and immediately available in variable pack sizes of 30 ml, 100 ml, and 250 ml up to 1 litre. 30 ml test samples are even offered at half price.

2.4 Electra 92 for applications on novolac-base resists - New variant SX AR-PC 5000/91.1 for negative CAR AR-N 7700 on glass

Novolac-based e-beam resists have other surface properties than e.g. CSAR 62, PMMA, or HSQ resists. Since September 2015, also a second version of Electra with the experimental sample designation SX AR-PC 5000/91.1 is available on the market which specifically and reliably works on novolac-based e-beam resists (e.g. AR-N 7500, 7700). This version is characterised by identical polymer properties, contains however a modified solvent mixture which exhibits improved coating properties on novolac-based resist layers.

With this second version of Electra, the novolac-based e-beam resist AR-N 7700.08 could be processed on quartz with a of resolution of 60 nm, which is a good resolution for a chemically amplified resist:

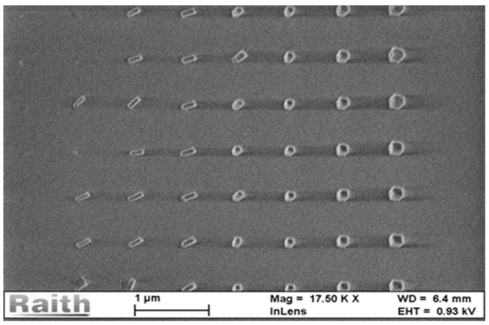

Fig. 5: 60 – 150 nm squares of AR-N 7700.08 (100 nm height) on glass

3. PPA-Litho project: First application examples of the new PPA resists

Several companies from Switzerland, Austria, and Germany cooperate in the Eurostar PPA-Litho project. So far, the quite complex synthesis of poly(phthalaldehydes) (PPA) could be optimised and was already successfully transferred to small-scale production. Different resist samples have meanwhile been produced from these polymers and are now tested with excellent results at the SwissLitho AG with a NanoFrazor.

The basic principle is simple: The resist layer is scanned with a hot needle. With each contact between needle tip and resist surface, the thermolabile PPA evaporates and the structures are thus transferred into the layer. In addition to the classic 2D structuring in which the entire layer is removed, the NanoFrazor is also able to realise 3D images in which only a part of the layer thickness is locally removed. A simple example for this procedure is the NanoFrazor image of the Allresist team presented on the MNE 2015 with a size of 5 x 5 µm.

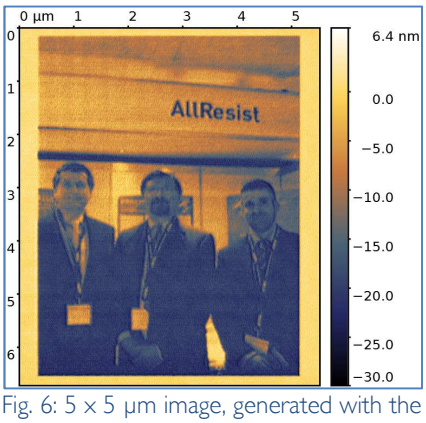

Fig. 6: 5 x 5 µm image, generated with the NanoFrazor (film thickness 44.7 nm)

Dr. Holzner (SwissLitho AG) demonstrated already specific application examples in his talk on the MNE. The following two slides (by courtesy of Dr. Holzner) show two lift-off processes for very small structures:

a) In lift-off process I, a PMGI layer (aqueous-alkaline developable polymer) is applied onto a substrate. This layer is coated with a PPA-resist and then patterned with the NanoFrazor. The PMGI is removed in a normal isotropic photolithography development step which produces the undercut. Subsequently, a sputtering with metal is performed. After the lift-off, the metal structures remain. This procedure is however limited with respect to the achievable resolution due to the isotropic development. Within the scope of this project, Allresist is working on the optimisation of the lower layer and intends to offer in the future customized resists of the AR-BR 5400 series also for this purpose.

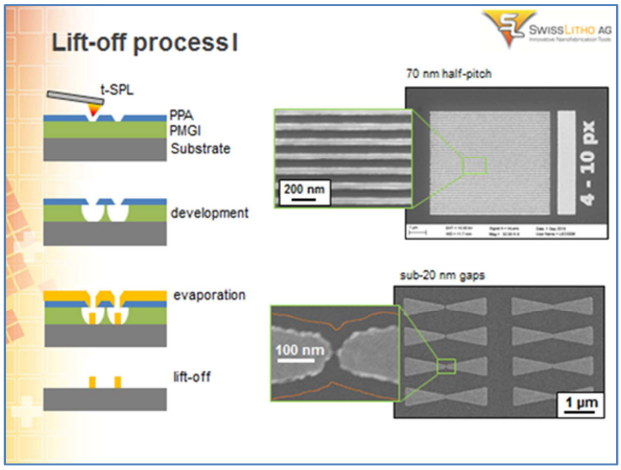

Fig. 7: Two-layer lift-off process with PPA as top resist

b) Lift-off process II is suitable for even finer structures. PMMA is used as bottom layer, followed by deposition of a thin SiO_2 layer and the PPA resist. This resist is patterned by NanoFrazor; the SiO_2 is removed with a CHF_3 and the PMMA with an O_2 plasma, followed by sputtering of the metal and lifting.

After completion of the project, Allresist and SwissLitho will offer a modular system of the different resists (PPA, PMMA, AR-BR 5400) to all interested users. These resists will of course also be available in small quantities since the resist consumption is generally low in this procedure.

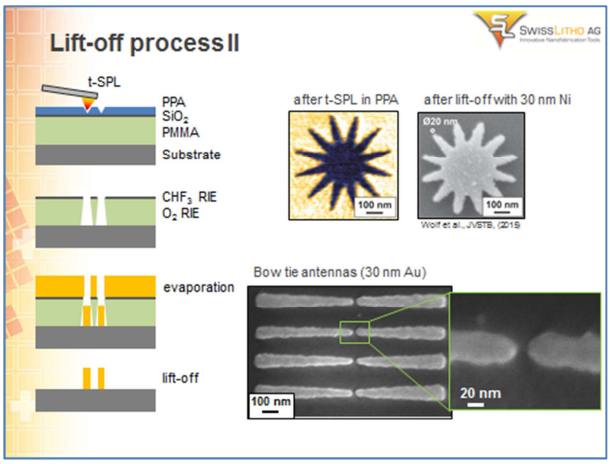

Fig. 8: Three-layer lift-off process PPA/ SiO_2/ PMMA

All users who have an e-beam lithography device can instead perform the two lift-off processes easily and in high precision with CSAR 62 instead of PPA resists. We will gladly provide further recommendations upon request.

4. Allresist turns 23 years old and rejuvenates

Today, on 16 October 2015, Allresist celebrates its 23rd company anniversary. We think that this event has deserved a few more news:

The 28 year-old Ulrike Dorothea Schirmer who has been working since 2011 at Allresist during her studies and is now partner since this year, will follow in the footsteps of her parents and become managing director in approximately 10 years. The continuity of Allresist is thus secured until the year 2054, and framework agreements until then are more than welcome ☺.

In her successfully completed studies as film producer, she has already demonstrated her over-average organizational and leadership talents. This is also reflected by her nomination for the Germany-wide "First Step Award" of the film industry as producer.

She will in addition shortly begin extra occupational distance studies in order to be able to control the future destinies of Allresist in two years even better as new Master of Management and Business Administration.

The second new addition to strengthen the team is the employment of Dr. Maik Gerngroß, a 31-year-old graduate chemist. With this decision, Allresist responded to the growing number of customers and scientific projects. The focus of his activities is on sales responsibilities, customer service and project management, but he will also contribute to new product developments. Gerngroß is a flexible team player, innovative, enthusiastic, creative and able to work well under stress. Please challenge him.

The pictures show both of them before and after their first Strausberg half-marathon with the Allresist jersey „Mit Allresist läuft's ".

For any future applications, we would in fact greatly appreciate half marathon times of less than 2:13 h for women and less than1:46 h for men ☺.

Fig. 9: Allresist staff member Ulrike Dorothea Schirmer and Maik Gerngroß ready to run

5. Chemnitz seminar "Electron-Beam Lithography" in the Fraunhofer Institute ENAS

We would like to draw your particular attention to the Chemnitz Seminar "Electron-Beam Lithography" on 4 November 2015 at the Fraunhofer Institute ENAS in Chemnitz. Nine experts will illuminate interesting aspects of e-beam lithography such as e-beam and CMOS direct writing, applications in optics and for MEMS/NEMS...

Detailed information concerning the lecture topics and speakers is available on the following page.

Matthias Schirmer will also give a talk which is focused on e-beam applications with both conventionally used as well as newly developed products such as CSAR 62 and Electra 92.

Interested parties may contact Allresist or Dr. Erben (jens-wolfram.erben@enas.fraunhofer.de) directly.

CHEMNITZER SEMINAR "ELEKTRONENSTRAHL-LITHOGRAFIE"

PROGRAMM

MITTWOCH
4. NOVEMBER 2015

Das Fraunhofer ENAS verfügt über spezifisches technologisches Know-how auf dem Gebiet der Smart Systems Integration sowie Mikro- und Nanoelektronik.

Im Rahmen eines langfristig angelegten Investitionsvorhabens, das von der Europäischer Union, dem Bund, dem Land Sachsen und der Fraunhofer-Gesellschaft gefördert wurde, gelang es, eine nachhaltige Verbesserung des technischen und technologischen Potentials unseres Institutes durch die Anschaffung und Inbetriebnahme von Ausrüstungen für die Herstellung von Nanometerstrukturen mit einer Auflösung von bis zu 20 nm zu erreichen. Kernkomponente der Gesamtinvestition ist die 50 kV Elektronenstrahl-Belichtungsanlage SB254 der Vistec Electron Beam GmbH (Jena), die eine hohe Flexibilität in der Bearbeitung von Forschungsthemen mit Nanostrukturen künftiger Generationen gestattet.

Unser Ziel ist es, anlässlich der Einweihung des Nanolithografie-Labs am Fraunhofer ENAS mit Fachkollegen und Interessenten sowie potentiellen Nutzern und Anwendern der Elektronenstrahllithografie ins Gespräch zu kommen und die neuen Möglichkeiten an unserem Institut vorzustellen.

Wir freuen uns, dass wir für diese Veranstaltung eine Reihe von exzellenten Referenten gewinnen konnten, die mit einem breiten Spektrum an anwendungsorientierten Vortragsthemen zu einem informativen Workshop beitragen werden.

10:00 – 10:10 Uhr	**Begrüßung |** Prof. Dr. Thomas Geßner, Dr. Danny Reuter, Fraunhofer ENAS
10:10 – 10:40 Uhr	**Variable Shaped Beam Lithography for Micro- and Nanotechnology** Dr. Matthias Hädrich, Vistec Electron Beam GmbH, Jena
10:40 – 11:10 Uhr	**E-Beam-Applikationen mit traditionellen und neuentwickelten E-Beam-Resists** Matthias Schirmer, Allresist GmbH, Strausberg
11:10 – 11:40 Uhr	**Elektronenstrahllithographie für die Optik – schnell, flexibel und präzise** Dr. Ernst-Bernhard Kley, Friedrich-Schiller-Universität Jena, Institute of Applied Physics, Dr. Uwe D. Zeitner, Fraunhofer IOF, Jena
11:40 – 12:10 Uhr	**E-Beam-Lithographie am IMS – Applikationen vom CMOS-Direktschreiben bis zum analogen Nanoimprint Template** Dr. Mathias Irmscher, Institut für Mikroelektronik (IMS CHIPS), Stuttgart
12:10 – 13:30 Uhr	Mittagspause
13:30 –14:00 Uhr	**Zonenplatten für die hochauflösende Röntgenmikroskopie** Dr. Stefan Rehbein, Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin
14:00 – 14:30 Uhr	**Module-Integration in eine 0,13 µm BICMOS-Technologie/ ESL-Applikationen** Dr. Andreas Mai, Leibniz Institut für innovative Mikroelektronik (IHP), Frankfurt/ O.
14:30 – 15:00 Uhr	**Elektronenstrahllithographie – Anwendungen am Fraunhofer Heinrich-Hertz-Institut** Ralf Steingrüber, Heinrich-Hertz-Institut, Berlin
15:00 – 15:30 Uhr	Kaffeepause
15:30 – 16:00 Uhr	**E-Beam Direktschreiben am Fraunhofer IPMS: Maskenloses Strukturieren für CMOS und MEMS/NEMS Applikationen** Dr. Christoph Hohle, Fraunhofer IPMS-CNT, Dresden
16:00 – 16:30 Uhr	**Anwendung der Elektronenstrahl-lithografie für MEMS/NEMS und 1D-Elektronik** Dr. Danny Reuter, Fraunhofer ENAS

We hope that you could find new ideas and inspiration in our report and encourage you to address your particular wishes to us.

The next issue of our AR NEWS will again be presented in April 2016.
Successful times until then!

Strausberg, 16.10.2015
Matthias & Brigitte Schirmer
Team of Allresist