AR NEWS

30th issue, April 2015, Allresist GmbH

Content:

Welcome to the 30th issue of AR NEWS. We would like to inform you again about the development of the company and our ongoing research projects.

1. Investment in sun energy – Allresist installed a rooftop photovoltaic system

Our last year turned out to be economically very successful. Allresist was thus able to make an investment in sustainable energy: since May 11, a photovoltaic system has been installed on our roof and fulfills our desire to not only reduce the general carbon dioxide emission in Germany, but also our constantly growing electricity costs effectively.

The 40 kWp photovoltaic system reduces the climate-damaging CO_2-emission by 21.100 kW per year. Taking into account our high own comsumption of energy and feeding in addition energy into the public grid, Allresist will save approximately 5.000 € in energy cost annually for the next 25 years.

The former Minister for Environment, Health and Consumer Protection of the State of Brandenburg, Anita Tack, congratulated Allresist on May11 on the inauguration of the new photovoltaic system and the successful synthesis of environmental and economical benefits. She wished the in 2012 honoured Environmental Partner of the Federal State of Brandenburg sunshine anytime. IHK-President Dr. Ulrich Müller expressed his pleasure that the small company Allresist not only represents a pioneer for excellent quality, but also for climate protection in Strausberg.

Fig. 1 Photovoltaic system installed on the roof of Allresist

2. Highly sensitive negative resist for laser direct exposure

In cooperation with the IZM and the TU Berlin, the negative resist AR-N 4400-10 was structured with a laser direct imaging system at an exposure wavelength of 405 nm. These investigations were conducted within the scope of the ZIM-project VEGAS which has meanwhile been completed successfully.

One aim of these experiments was to generate column-shaped arrays which may serve as stamps for the fabrication of patterns in identity or chip cards. Fig. 2 shows different arrays with column diameters varying from 5 µm to 50 µm. The exposure dose ranged between 7 - 200 mJ/cm², the film thickness was 11 µm in this test series.

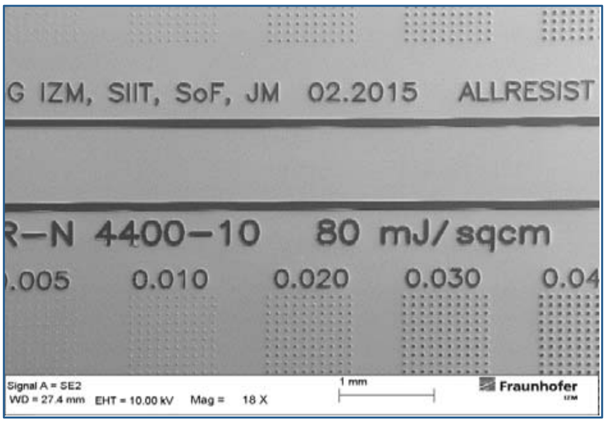


Fig. 2 Test areas with different column diameters

The first remarkable result turned out to be the sensitivity of the resist reached at 405 nm. As chemically enhanced resist, AR-N 4400-10 is in particular predestined for a high sensitivity in the i-line range (365 nm). That however already a dose of 7 mJ/cm² is sufficiently high to achieve a complete layer build-up at an exposure wavelength of 405 nm and a film thickness of 11 µm, is a surprisingly promising result.

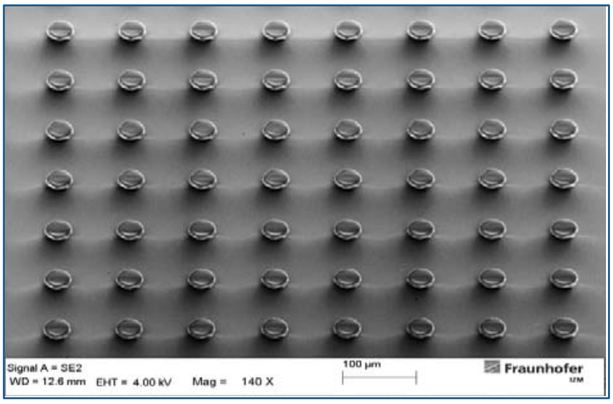


Fig. 3 40 µm-columns with a dose of 7 mJ/cm²

In addition to the generation of cylindrical columns, this project was also aimed at the realisation of columns with undercut and cone-shaped columns.

With parameters as selected for these experiments (see Fig. 3), a slight undercut of the structures can be observed: Due to the absorption of the resist, the upper part of the layer is more strongly exposed and thus more intensively crosslinked. In contrast, the lower part of the structure is exposed to a lesser extent and thus also less crosslinked. Consequently, a slight undercut is obtained if the developer attacks the lower layer also laterally. A more pronounced differentiation of the crosslinking process (in order to obtain an even larger undercut) is however not possible if laser light is used. If a larger undercut effect is intended, conventional photolithography with masks and minimum exposure dose has to be chosen in this case (see Fig. 4 + 5).

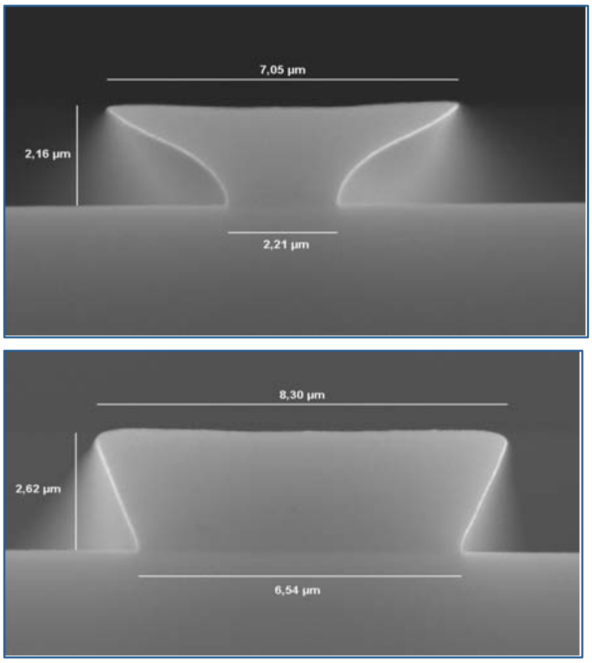
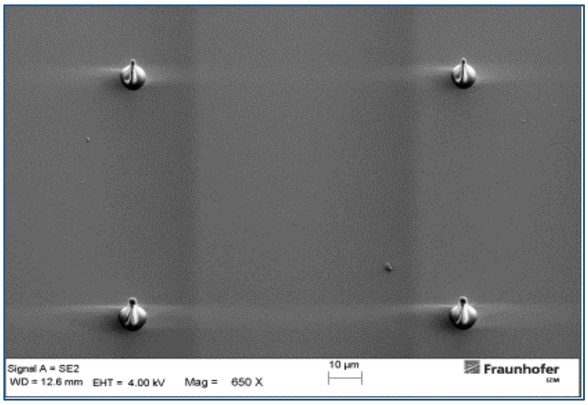
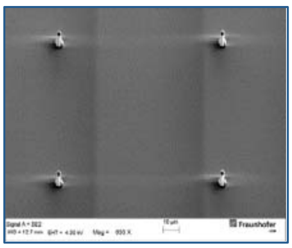


Fig. 4 + 5 Undercut structures of AR-N 4450-10 at minimum exposure dose

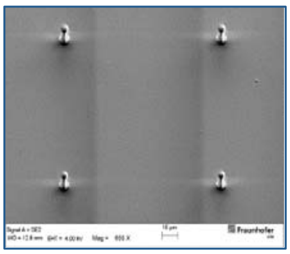
The required laser light dose largely depends on the desired structural size. In picture series 6, 5 µm-columns are shown which were obtained with different exposure doses. While the 40 µm-column (Fig. 2) confirms a complete layer build-up at 7 mJ/cm², is this dose not sufficiently high for the 5 µm-column and results in a pointed cone. With increasing exposure dose (above 30 mJ/cm²), the shape of a column is obtained. If even higher values are used, the diameter of the cylinder increases due to the overexposure and the scattered light associated with it. At 120 mJ/cm², already diameters of 7.5 µm are reached.



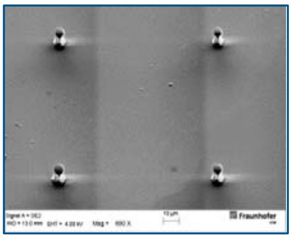
Picture series 6 with 5 different exposure doses: 7 mJ/cm² 5 µm

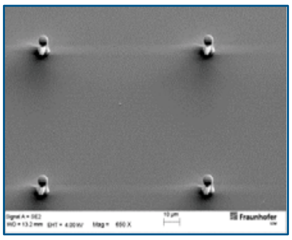


40 mJ/cm² 5 µm



70 mJ/cm² 5 µm





90 mJ/cm² 5 µm 120 mJ/cm² 5 µm

In the case that relatively large structures > 20 µm are to be realised with AR-N 4400-10, it is also possible to work with the maximum sensitivity of 10 - 20 mJ/cm² at a film thickness of 10 µm. If the structural size range includes in addition considerably smaller structures, a range between 30 and 40 mJ/cm² should be used since these doses provide a correct reproduction of larger structures. If however a significantly higher energy is applied, structures will widen and form – in particular at the bottom - undesirable foot-like protrusions (Fig. 6).

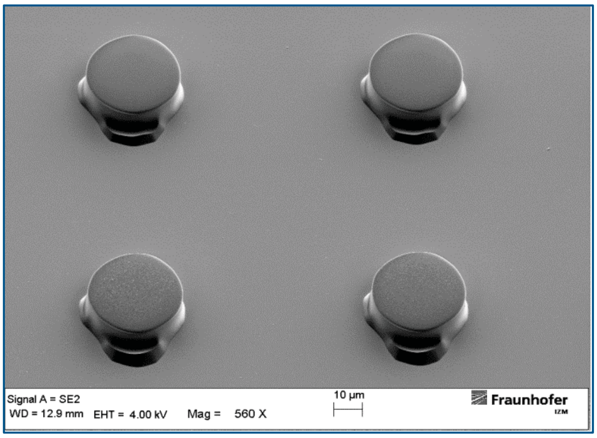


Fig. 6 Overexposed 30 µm-columns obtained at 200 mJ/cm²

With AR-N 4400-10, a highly sensitive and versatile negative resist is available to the user which is not only excellently suited for masks photolithography, but also for laser direct exposure at 405 nm.

3. Further CSAR 62 applications – high-precision rectangular structures

The fabrication of very small, highly accurate rectangular structures was aimed at in the IAP of the Friedrich-Schiller-University Jena. For this purpose, a two-layer system was composed of AR-P 6200.09 (top layer, 100 nm) and AR-P 617.06 (bottom layer, 300 nm). After exposure using the e-beam writer Vistec SB 350OS (Variable Shaped Beam) and 50 kV, CSAR 62 was structured with developer AR 600-546 and the bottom layer then developed in developer AR 600-55. The subsequent coating step was performed with gold (30 nm), followed by a lift-off in a mixture of acetone and isopropanol.

The results are presented in Fig. 8 which shows structures with a size of 38 nm and a distance of approximately 40 nm between structures. The small curvature radii of the corners at the inner side of the "L"-structure are assessed as especially positive.

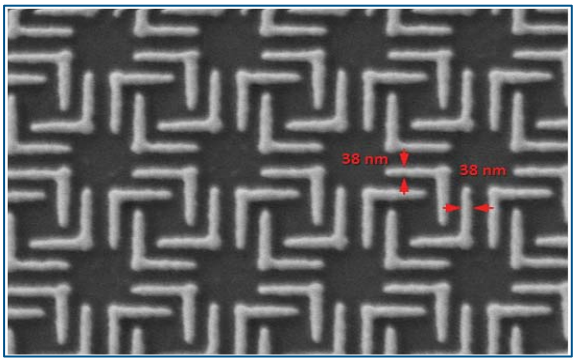


Fig. 8 High-precision L-shaped structures, generated with system AR-P 6200.09 / AR-P 617.06

This workgroup targeted a similar objective for the fabrication of square structures. Here, too, the aim was to achieve a particularly high resolution of the corners. For this purpose, a CSAR 62-film with a thickness of 100 nm was irradiated with 50 kV and developed with developer AR 600-546. As intended, edges and corners of the 130 nm-squares are characterised by an excellent quality (see Fig. 9)

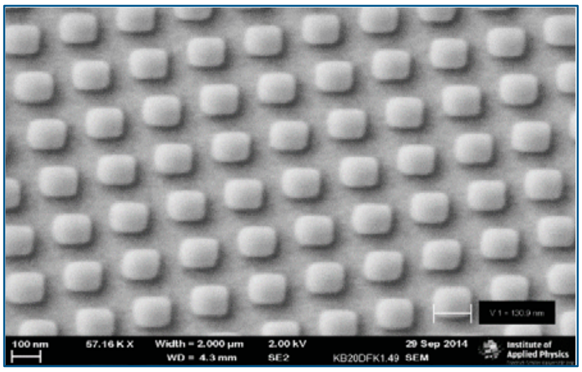


Fig. 9 130 nm-squares with accurate dimensions using CSAR 62

4. New results with Electra 92

Allresist offered an inexpensive conductive resist Electra (SX AR-PC 5000/90.2 since March 2014.)

The synthesis and in particular the demanding purification of the polyaniline derivative has meanwhile become routine at Allresist. The feedback from numerous users with respect to the application properties of Electra 92 was very positive. The results of the MLU Halle which were obtained during the unproblematic structuring of a two-layer PMMA system on quartz substrates for lift-off processes were already reported in the last issue of the AR NEWS.

An accurate structuring on quartz substrates as well as using other e-beam resists like e.g. HSQ is not possible if no conductive coating is applied. We now received notification from the Raith GmbH that after coating with Electra 92, also HSQ-resists on a quartz-substrate could be structured in very good quality. This has, according to Mr Rudzinski (Raith GmbH), so far not been possible with any other conductive coating. The resist (thickness of 20 nm) was irradiated with the required dose of 4300 µC/cm² (area dose). SX AR-PC 5000/90.2 was subsequently completely removed with warm water within 2 minutes, and no residues could be observed. After development of the HSQ resists, structures with 20 nm-lines remained (Fig. 10).

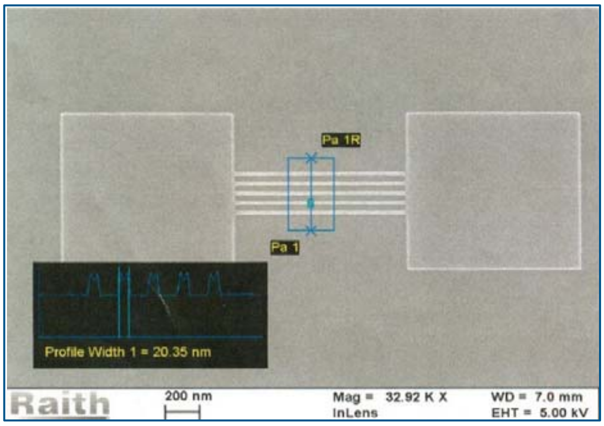


Fig. 10 20 nm-lines of HSQ, prepared on quartz with Electra 92

As several users reported, could Electra 92 also be successfully applied as conductive coating for SEM-samples. SEM-images with high quality are only obtained if the negative charges transmitted during the electron scan are completely discharged, since otherwise only severely distorted images of structures will result. Electra 92 turned out to be a good alternative to the generally used sputtering process (evaporation of expensive noble metals on the substrates to be investigated).

Mr Bjarke Rolighed Jeppesen (Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, 8000 Aarhus C, Denmark) successfully used Electra 92 on 950k PMMA for the generation of plasmonic structures (Ag-dots on quarts substrates). Mr. Jeppesen commented very positively on the simple and reliable handling of this conductive coating. He in particular pointed out that it is favourable for the build-up of a homogeneous conductive layer to first wet the entire substrate surface with resist solution before the spinning process is initiated. The following pictures were kindly provided by Mr Jeppesen (Fig. 11).

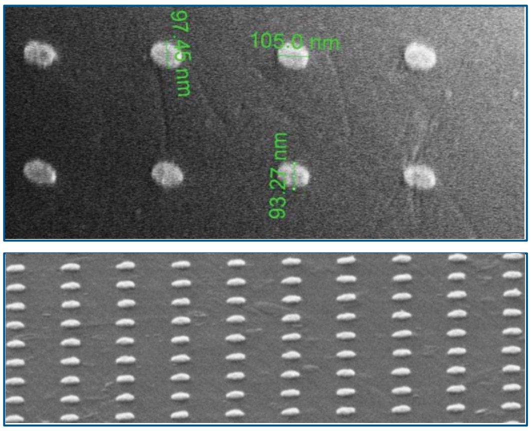


Fig. 11 Silver nanoparticles on quartz substrate

We hope that you could obtain new ideas and inspiration from our report and encourage you to communicate us your particular wishes.

The next issue of our AR NEWS will be presented in October 2015.
Until then, we wish you and us every success.

Strausberg, 11.05.2015
Matthias & Brigitte Schirmer
in the Team of Allresist