AR NEWS

22nd issue, April 2011

Allresist GmbH

Content:

Welcome to the 22nd issue of the AR NEWS. With the addition of Dr. Dipl.-Chem. Christian Kaiser to our team, we are now able to accelerate customer-specific developments even faster. We would like to inform you again about our ongoing research projects and the further development of our company:

1. Allresist certified according to ISO 14001 for environmental management

Environmental issues were given a high priority already when the Allresist Company was founded. With the construction of the new company building in Strausberg in 1999, a large number of environmental protection measures were realized (solvent recovery, high energy efficiency due to new equipment and machinery, economic use of resources by increasing batch sizes).

By 2005, we replaced all health-hazardous solvents and raw materials by more environmentally compatible alternatives.

However, in order to fully meet the high obligation of chemical enterprises to the environment, we decided in 2010 to introduce an environmental management system according to DIN 14001:2004. With great commitment, our quality management representative (QMB) Doris Perseke established a material and energy balance which was the basis for the first-time certification.

On February 11, both the QM repeat audit and the certification of the UM were conducted by the TÜV-Süd.
Dr. Leonhardt (QM) and Mr. Kluthmann (UM) convinced themselves of the high quality of all processes and issued both certificates which are now available for download on our web page.

Group photo with both auditors after a successful QM- and UM-audit

2. Completion of the project "Cross-linkable polystyrenes for OLED applications"

Aim of this project was the production of qualitatively improved organic light-emitting diodes (OLEDs) or organic field-effect transistors (OFET). Within the scope of the project, particularly alternative cross-linking methods as commonly known in the field of resist technology should be transferred to polymer materials relevant for applications as mentioned here. The following tasks should be realized: complete cross-linking reaction, shorter process times and lower cross-linking temperatures. The cross-linking procedures could furthermore be optimized for specific microelectronics applications. In photolithography and especially in electron beam lithography, great interest exists for conductive as well as for insulating films and structures.
Fig. 1 shows the structure of an OLED. In the schematic sketch, the active polymer is composed of only one layer. Improved features are achieved if single functions such as the emitting or the electron-conducting layer can be generated separately.

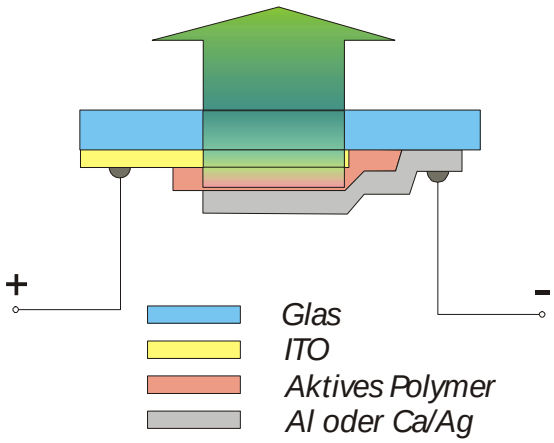


Fig. 1 Schematic sketch of an OLED

In order to apply polystyrene-based polymer layers on top of each other, the polymers for the first coating step first of all had to be well soluble in solvents. Then however, films for the second (or third) layer had to be insolubilized, which was possible by an addition of cross-linkers. With this procedure, a selective multi-layered structure could be realized. The higher efficiency of these OLED-devices was confirmed by investigations of our partners in the Fraunhofer Institute for Applied Polymer Research in Golm.

The cross-linking of polymers investigated here could also be used for the fabrication of microstructures with photolithography. After selection of a developer system, structures as shown below could be realized in thin 100-nm films. In following experiments, these results will be transferred to electron beam lithography applications. The demand for conductive e-beam resists still remains high, in order to be e.g. able to eliminate charges from quartz-substrates. Some of the modified polystyrenes possess (semi)conductive features, which possibly could be sufficient for this purpose.

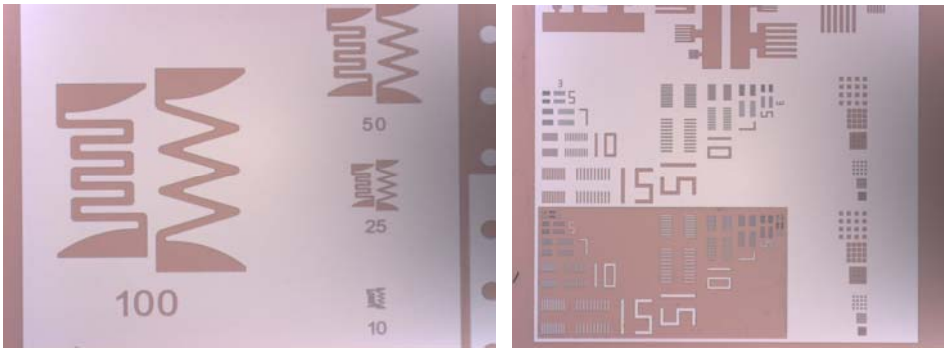


Fig. 2 Structures of aryl-substituted polystyrenes with electron-conducting properties

With these results we would like to encourage our customers and partners to participate in this development work and to contribute own experiences and requirements.

3. Results of bilayer lift-off patterning with Allresist e-beam resists

Bastian Büttner and Frank Syrowatka from the research group of Prof. Schmidt (MLU Halle, Institute of Physical Chemistry) conducted investigations on our behalf regarding the fabrication of lift-off structures with our PMMA e-beam resists. One of the goals was to achieve a defined undercut with the highest possible resolution. Undercuts in PMMA bilayer systems can be produced if the bottom layer has a lower molecular weight than the upper one. The low-molecular weight PMMA layer possesses a slightly higher sensitivity, so that the developer starts to dissolve also the trench sidewalls after complete development. The intensity of this dissolving process is dose-dependent: the higher the exposure dose, the stronger is the resulting undercut (see below). Formation of an undercut is supported by the proximity-effect (backscattering in the lower 10-nm films).

Particularly well suited for a large undercut is a system with distinct molecular weight differences, e.g. 50k/950k. In this case however, differentiation is already so high that the maximum resolution is lower than with the PMMAs investigated here. For this reason, two PMMA resists were chosen with only minor differences regarding the molecular weight.

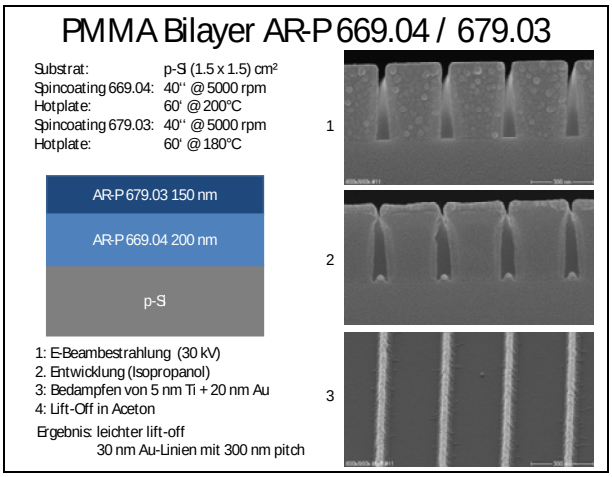


Fig. 3 Bilayer 600k/950k

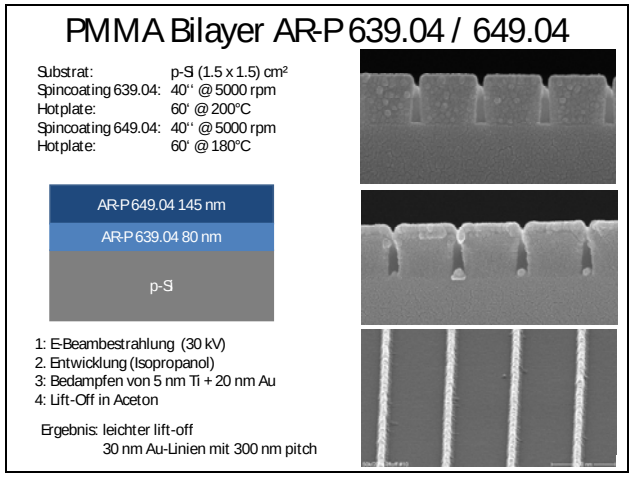


Fig. 4 Bilayer 50k/200k

Samples were prepared as described in Fig. 3 and 4, exposed to different doses and developed. Fig. 5 shows lift-off structures of a dose-variation of the 600k/950k system. Above a dose of 2000 pC/cm, the entire layer is developed. On the resist surface, a resolution of 25 nm is measured, which increases to 45 nm if the exposure is intensified (6000 pC/cm). The sidewall angle generated also increases with the higher energy (see Fig. 4 undercut 1), and the undercut increases equally (undercut 2).

Comparable results were also obtained with the two-layer resist 50k/200k. For this system, a slightly larger undercut and a higher sensitivity were determined (see Figure 6).

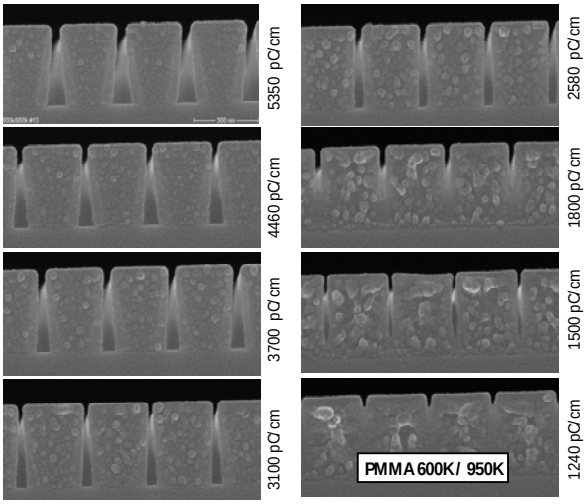
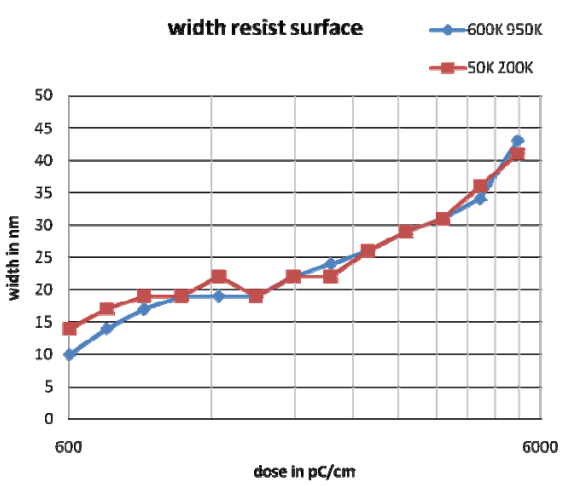
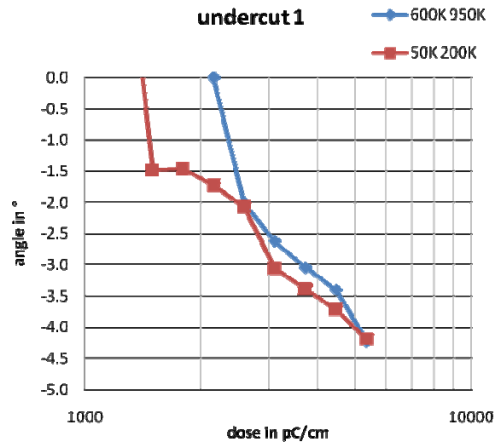


Abb. 5 Dose-dependent undercut formation





Ergebnisse:
600K / 950K:
Geringere Empfindlichkeit
Lift-off Schichten > 150nm durchführbar
➔ zuverlässiges Lift-off-System für einfache Anwendungen
50K / 200K
Höhere Empfindlichkeit
Größerer Unterschnitt
➔ Anwendbar für komplizierte Lift-offs

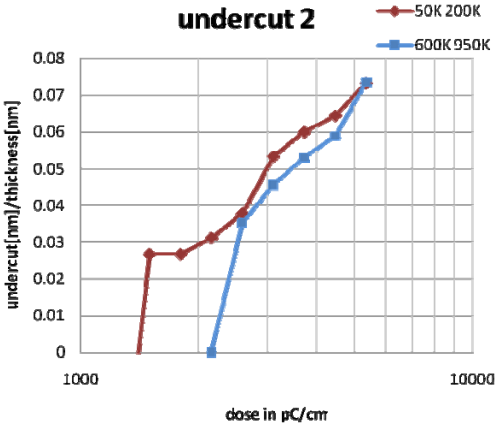


Fig. 6 Results of bilayer patterning

Resist structures were coated with titanium and gold by vapour deposition. The subsequent lifting step was performed with acetone. The removal of the resist mask was unproblematic. With both bilayers investigated here, 30-nm gold lines could be produced.

We hope that we were able to offer our customers suggestions for own process optimizations and are gladly at your disposal for further discussions.

4. Fabrication of sub-µm grating patterns using laser interference lithography

We increasingly receive interesting results obtained with our resists from Asia. Our business partner GermanTech in China, represented by Dr. Zhou and Mrs Yue Tian, organize the distribution and advise customers together with us. The following report of Prof. Chen Hong shows the application of AR-P 3840 for the production of sub-µm grating patterns. Particularly remarkable is that at a film thickness of 120 nm, a resolution of up to 70 nm can be achieved, which illustrates the high potential of our photoresist.

Excerpt from the report of Dai Longgui, Ding Peng and Chen Hong, Renewable Energy Laboratory, Institute of Physics (IOP), Chinese Academy of Sciences (CAS), led by Prof. Chen Hong:
„We have fabricated sub-micrometer photoresist grating patterns on silicon by laser interference lithography. We can easily obtain the different sub-micrometer periods grating, from 200 to 800 nm, by the control of the interference angle, the exposure dosage and the development condition. For details of the process parameters, please see Tab. 1.“

Process Parameters	300nm	400nm	600nm
Dilution ratio of photoresists (AR-P 3840 : AR 300-12)	1:3.5		
Rotation speed of adhesion promoter AR 300-80	4 000 rpm		
Thickness of adhesion promoter AR 300-80	15 nm		
Rotation speed of diluted photoresist	4 000 rpm		
Thickness of photoresist	120 nm		
Temperature and time of prebake (hotplate)	90°C, 2 min		
Exposure dose (325 nm wave length)	20 - 100 mJ/cm^2		
Dilution of developer (AR 300-47 : DI-water)	3:1		
Temperature and time of development	Room temperature, 10 – 30 s		
Temperature and time of post-development bake (hotplate)	110 °C, 2 min		

Table 1 Process parameters of laser interference lithography using AR-P 3840

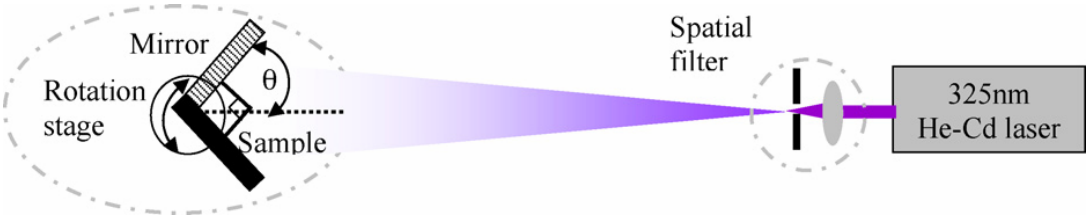


Fig. 7 Experimental setup of laser interference lithography

Figure 8 shows a 300 nm grating pattern. At a film thickness of 111 nm, the period is 281 nm, with a width of 100 nm for the single line. Fig 9 shows a single line of 72 nm width in a 400-nm grating.

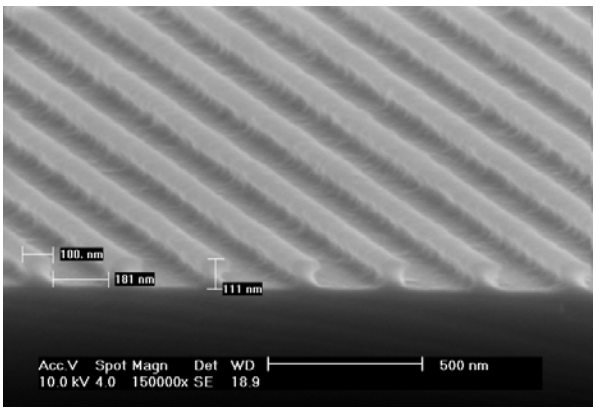


Fig. 8 Photoresist lattice with 300-nm period

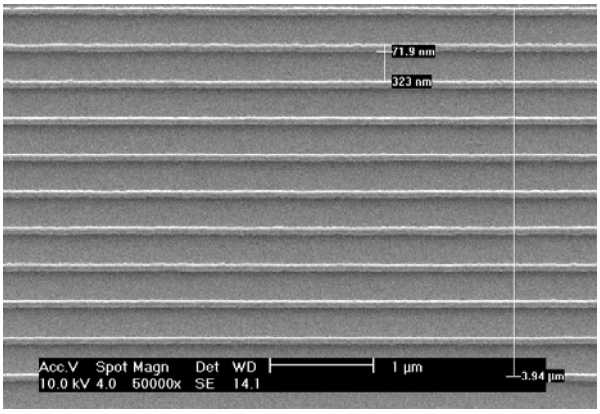


Fig. 9 Lines of AR-P 3840 with 72 nm width

With this interesting report, we would like to particularly invite our foreign partners to share their results and experiences and to further develop new technologies and resists together with us.

5. Quality Day 2011 and announcement of the Quality-Award Berlin-Brandenburg 2012

The Minister for Economic and European Affairs of Brandenburg, Ralf Christoffers, and the Senator for Economics of Berlin, Harald Wolf, announced the Quality-Award Berlin-Brandenburg 2012 at the Quality Day in Potsdam. The event was again organized by the Association for Promoting the Quality in Brandenburg, and supported in form and content by Brigitte Schirmer in her function as Ambassador for Quality. In the progress report presented by Mrs. Schirmer, she encouraged the companies to participate in the Q-Award Competition which is based on the EFQM-model. Companies who take up this high challenge will not only win the prize, but are also rewarded with satisfied customers and employees, optimally organized processes and excellent sustainable results.

Experiences were also shared and passed on during the subsequent panel discussion, as well as advantages emphasized for those companies who pick up the path to Excellence (EFQM).

With our commitment to the concept of excellence, we would like to contribute to a high-level corporate culture particularly in the capital region and also throughout Germany.

Announcement of the Quality Award 2012 by the Economic and European Affairs of Brandenburg, Ralf Christoffers

Announcement of the Quality Award 2012 by the Minister for Inspiring panel discussion, where experiences were passed on to interested companies

With this presentation of our development work, we hope to have made useful suggestions for you and look forward to a constructive and creative cooperation.

The next issue of the AR NEWS will again be presented in October 2011, one year before our 20th foundation anniversary. Successful times until then!

Strausberg, April 28, 2011

Matthias & Brigitte Schirmer

Team of Allresist