AR NEWS

15th Issue

Allresist GmbH

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1. 15th anniversary of the Allresist company - 15 successful years

Valued reader of the AR NEWS, we would like to inform you again about the further development of the Allresist and our products:

In the context of our new strategic orientation and on the way to business excellence, we defined our vision "100 years of Allresist". At first sight, this vision may appear presumptuous, but this statement reveals important company goals: reliability, long-term customer loyalty, moderate, stable growth, and fair business relationships based on mutual benefits with all our partners. From an economic point of view, the 15th year was the most successful year for us, and we are also looking back on promising research results and the establishment of new alliances. We will put our increased capacities even more strongly into the service of our customers.

On the Micro System Technique Congress in Dresden, a research group of the GMM was founded which is aimed at nano-micro integration. Allresist is one of the founder members. Due to our expertise, ranging from the generation of smallest structures with e-beam lithography (nano) to the production of deep structures using LIGA-techniques (micro), we feel predestined to make a constructive contribution to this research group. The mix-&-match technology which we present in item 4 of this issue is only one example of an integrative contribution. We would be pleased to pass on more detailed information to all AR NEWS readers who are interested to participate in this research group.

In the following articles, we would like to inform you about our latest research developments. We wish and hope that these news will find your interest and might even encourage a stimulating cooperation in the future.

2. New HF-stable resist system - SX AR-PC 5000/40

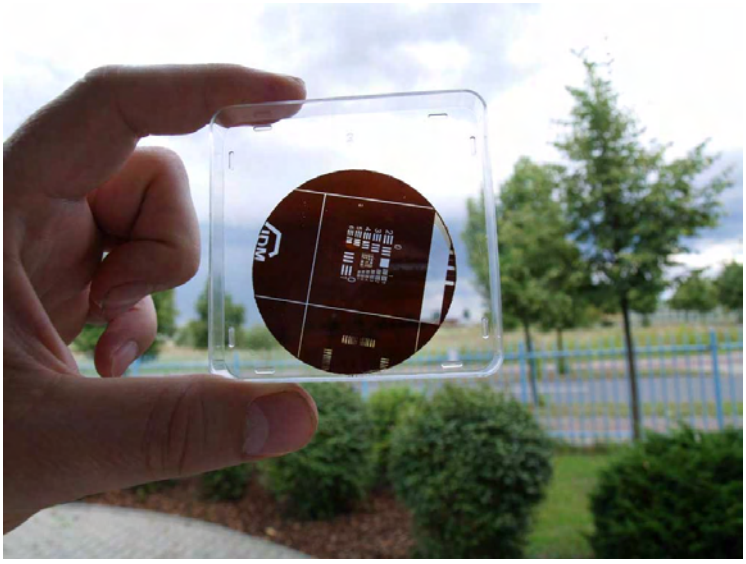
In the 13th issue of the AR NEWS 2005, we reported on first advances with the production of HF resistant protective coatings. Together with the Institute of Thin Film Technology and Microsensoric Technologies e.V. Teltow, we submitted a PRO INNO II project proposal to the AiF which was approved of in July 2006. In the context of this project, a photolithographic patterning using a two layer system was successfully turned into reality, which now provides the opportunity to use a simple technology for the generation of structures in glass and silicon oxide, respectively.

In a first step, SX AR-PC 5000/40 (black coating) is spin coated onto the glass substrate. If concentrated hydrofluoric acid (30 – 50 %) is used, the film thickness of the protective coating should at least be 8 µm. For short etching times or at low concentrations of HF, a smaller film thickness can be used as well. The following soft bake adjusts the residual solvent content in the film to a specific value. This is important in order to avoid cracks in the film during development. Subsequently, a photoresist is spin coated onto the black coating and baked. For this step, the film thickness again plays an important role. Films of about 10 µm thickness guarantee that the residual solvent content in the protective coating remains constant. The photoresist is patterned with conventional procedures (exposure and aqueous-alkaline development). The following development with a solvent (X AR 300-74/1) which dissolves the black coating very well but the photoresist basically not at all removes the protective coating from those areas which are freely accessible after development. Due to the isotropic solvent, a minor widening of the structures (underetching) occurs. This effect can be corrected by the use of smaller initial sizes. The photoresist should finally be removed with a strong base (e.g. AR 300-73), since it is otherwise washed away during the HF etching and then contaminates the etch bath. Before etching, the back side of the substrate is protected with SX AR-PC 5000/40. The following table lists the process steps:

Process step	**Parameter**
Coating 3.500 rpm with SX AR-P 5000/40	8,0 µm film thickness
Soft bake	50 °C, 25 min., convection oven
Coating 1.000 rpm with AR-P 3250	12,5 µm film thickness
Soft bake	50 °C, 15 min., convection oven
Exposure	250 mJ/cm²
Development with AR 300-26 (1:1 diluted)	60 sec.
Development SX AR-P 5000/40 (X AR 300-74/1)	5 – 10 sec.
Removing photoresist (AR 300-73)	60 sec.
Removing after HF etching (X AR 300-74/1)	30 sec.

Table 1 Process parameters for the two layer black coating process

In the etching process with highly concentrated hydrofluoric acid, the film size of both resists (together approx. 20 µm) results in a minimum resolution of approx. 10 µm. For deep glass etchings, however, typically only larger structures are used.



Picure 1 Resist pattern obtained with hydrofluoric acid-stable SX AR-PC 5000/40

☛ The development work for this system is not yet finished, and features will further be optimised in the frame of this project. We would appreciate any dialogue or comment concerning the properties of this new resist system.

3. Conductive protective coating for PMMA e-beam resists – SX AR-PC 5000/90

In e-beam lithography, often a charging of the substrates can be observed, which is due to the irradiated electrons. This effect is particularly pronounced when wafers with isolation features are used, such as e.g. silica. As a result of this charge process, structures may be deformed since the writing electron beam is scattered, This is particularly perturbing for the generation of sub-100-nm structures. So far this was corrected by evaporating a thin metal layer onto the PMMA prior to exposure, which dissipates the electrostatic charge. This layer however has to be removed before the development step.

With our new development SX AR-PC 5000/90, Allresist now offers an alternative. Polythiophenes and polystyrene sulfonates are dissolved in an alcoholic solvent mixture. This conductive protective coating is applied onto the PMMA resist via spin coating. Depending on the spin rotation, the film size is in a range between 50 and 100 nm. The bake is performed at 105 °C (2 min. hot plate or 25 min. convection oven), followed by exposure. The conductivity of the thin films was determined to be approx. 1×10^4 ohm cm.

After exposure, SX AR-PC 5000/90 is easily rinsed off with water. A conventional development of the PMMA resists can be carried out after the bake. To date, the conductive protective coatings can only be used for PMMA resists. Films of the negative e-beam resists on Novolak basis (AR-N 7500 and 7700) are attacked by the solvent mixture, thus leading to a roughening of the surface after removal of the protective coating. An in-house Allresist project now tries to solve this problem. We will report about experiences of our users and the final optimisation of this conductive coating in the next issue of the AR NEWS.

4. Resists for the mix-&-match technology

In the future, demands on a maximum resolution will increase still further. The 32 nm line & spaces pattern is one of the latest demands of the industry. A technology which is able to meet these demands already today is the electron beam lithography. But on one chip, not only the smallest structures have to be realised, but also larger ones – and this is a disadvantage of the e-beam lithography. In order to be able to expose larger areas, long writing times are required which put the economic efficiency of this procedure into question.

One solution of this problem could be the use of a mix-&-match technology. Small structures are written with an electron beam, and large structures are then added with UV lithography. This technology is a specific example for the nano-micro-integration which was presented in our editorial article.

In the scope of regularly scheduled optimisations of our e-beam resists AR-N 7500 and AR-N 7700, we will – motivated by various customer requests – test these resists with respect to their applicability for mix-&-match technologies. Both have already demonstrated their qualities as plasma etch resistant e-beam resists. AR-N 7520 is photosensitive in the UV range from 248 nm to the i-line, AR-N 7700 can even be patterned until the g-line, thus providing excellent conditions for a use in mix-&-match technologies. Main goal of these investigations is now to coordinate the process parameters of both methods in such a way that, after having performed these two different exposure procedures, a development can be carried out in one step.

We would therefore like to encourage a participation of interested customers and look forward to your response.

5. New project to assess improved features of CAR 44 for high thickness layers

In cooperation with the BESSY GmbH, Berlin, we started a small project which is aimed at the qualification of CAR 44 for thicker films. During the trial phase, we so far received many positive feedbacks concerning application features of AR-N 4400. However, some of the results are still not satisfactory for us. The structural quality of films thicker than 200 µm is still not sufficient. The main reason for this is based on the drying properties of the resist layer. These specific characteristics are now under thorough investigation. Since CAR44 is produced from our own raw materials, we have a wide range of variations at our disposal. We will therefore investigate various solvent mixtures and optimise the structural quality of thick layers in cooperation with our partners of the BESSY GmbH.

At the same time, we will also consolidate the good results with respect to the batch-to-batch reproducibility of the negative resist. An insufficient batch-to-batch reproducibility is a problem that some of the competitive products have to deal with. As already outlined during our presentation on the GMM-Workshop in Karlsruhe in May 2007, CAR 44 consists of six main components: acid generator, multi-functional Novolak, Novolak base, solvent, surfactant, and sensitizer. These component exhibit entirely different influences on the lithographic parameters. Table 2 shows the magnitude of these influences.

Component	Sensitivity	Gradation	Develop time
Acid generator	+++	+++	++
Multi-funct. Novolak	++	+	++
Novolak	+	+	+++
Solvent	-	-	(+)
Surfactant	(+)	-	-
Sensitizer	++	-	-

Table 2 Influence of components on the lithography +++ wide influence; - no influence

Due to the divergent properties of single raw materials we are able to correct our experimental settings until the values of the previous batch are obtained. For a long time, this approach has already successfully been implemented for the fabrication of our positive resists. We are thus able to guarantee a constant quality in a continued production process.

Prospective customers who are interested in a film thickness of up to 500 µm will be informed about the progress with our tests. In addition, we would be pleased if we could make other readers curious about our new developments.

6. Resist films for absorption up to the NIR range – SX AR-PC 5000/32

We often receive enquiries concerning the availability of resists which absorb in the wave length range of 500 – 1500 nm. For metrological applications, laser or light emitting diodes are employed which can be utilised for measurements in the range as mentioned above.

In the spectral range of 500 – 1100 nm, photoresists are absolutely transparent. All attempts to pattern resists at a wave length > 550 nm failed so far. However, by taking advantage of the thermal effect e.g. of a CO_2-laser it might be possible to write structures in the NIR range. Concept tests with one of our new resists showed that we are able to utilise the thermal effect for patterning. If you should be interested in this idea, we will be pleased to be at your disposal for discussions.

But also the spectral NIR range can be used in resist technologies. We added dyes to our resists which exhibited a maximum absorption in the wave length range as requested by the user, and which were sufficiently soluble in resist solvents. Some applications require such films for the purpose of protective coatings, a patterning is thus not necessary.

One example is presented in diagram 1, which shows the absorption spectrum of SX AR-PC 5000/32. The user of this resist intended to realise a maximised absorption at 1064 nm together with a medium film thickness.

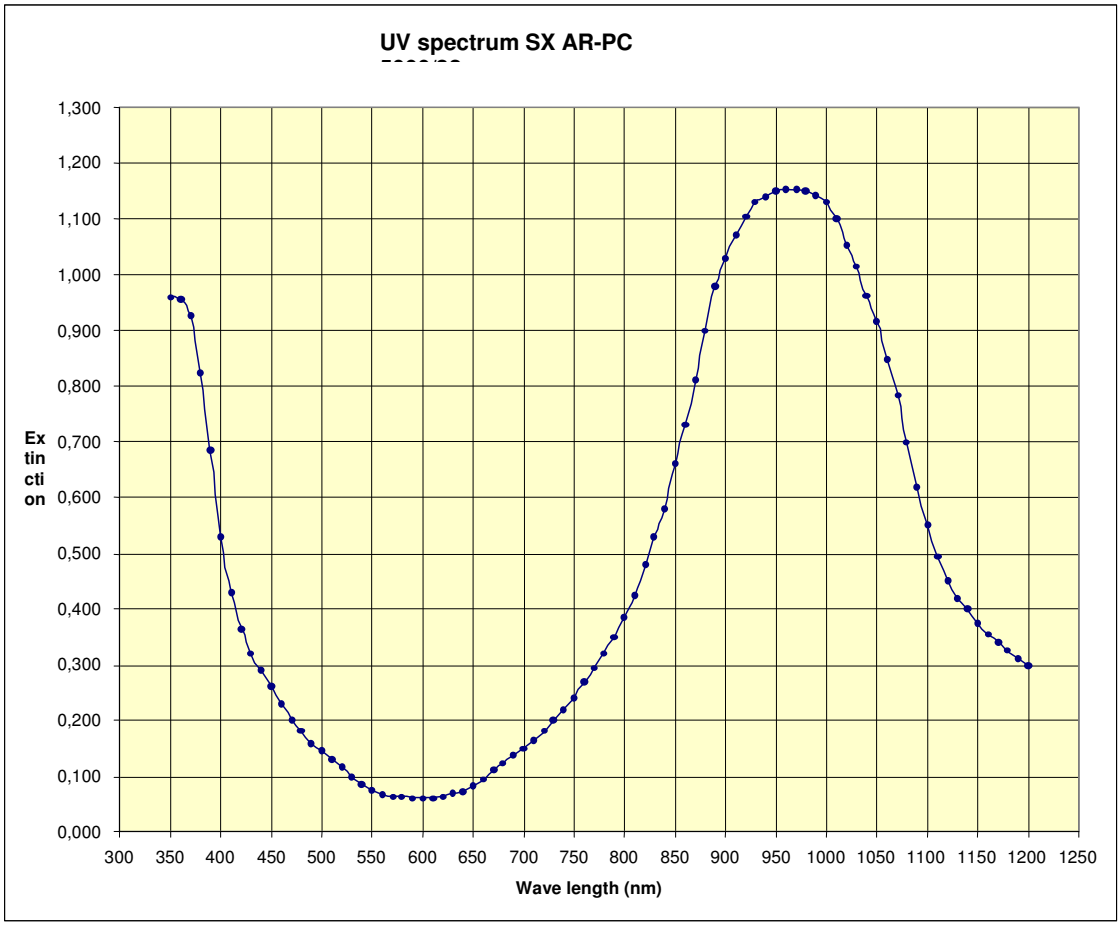


Diagram 1 Absorption spectrum of SX AR-PC 5000/32 (film thickness 1.4 µm)

If desired, a patterning of the coloured films is nevertheless possible in most cases. The photosensitive range of the photoresist of 300 – 450 nm is partially transparent, as shown in diagram 1. This is sufficient to allow a patterning after a light sensitive component has been added to this specific photoresist.

With this presentation of our recent results, we hope to have motivated you to tackle new applications with our photoresists.

We will present our next issue of the AR NEWS around Easter 2008. Successful times until then!

Strausberg, 16.10.2007

Matthias & Brigitte Schirmer

Allresist Team