# PMMA Polymers: 50K, 200K, 600K, 950K corresponding E-Beam Resist Series: AR-P 631, 641, 661, 671 (chlorobenzene) AR-P 632, 642, 662, 672 (anisole) and AR-P 639, 649, 669, 679 (ethyl lactate)

## 1. General Description

**The E-beam Resists Series AR-P 631-671, AR-P 639-679** and **AR-P 632-672** are positive working resists suitable for all kinds of e-beam applications. These resists are filtered to a particle size of 0.2 µm.

The resists are designed to meet critical geometry requirements of mask production in the advanced integrated circuit fabrication. The PMMA-polymer layers are distinguished by an excellent adhesion on glass, silicon and metal.

The polymer 50K has an about 20 % higher sensitivity as the polymer 950K. The developed patterns are thermal stable up to 120 °C.

**The resists AR-P 631-671, AR-P 639-679 and AR-P 632-672** can be used for multilayer processes and planarisation. Resists with low solids content for resist thickness down to 30 nm are suitable especially for the nanometer lithography.

## 2. Chemical Composition

Polymers based on methyl methacrylate with different molecular weights, dissolved in chlorobenzene (AR-P 631-671, Flash point (Fp): 28°C, anisole (AR-P 632-672, Fp: 43°C), ethyl lactate (AR-P 639-679, Fp: 36°C).

## 3. Process Description and Storage

| | |
|---|---|
| • **Coating** | 6000 - 2000 rpm in air conditioned working areas at 20 - 25 °C and a humidity of 30 - 50 % (☞ Tab. 2). |
| • **Baking** | 150 - 190 ± 2 °C, 60 min convection oven or 150 - 180 ± 2 °C, 2-5 min hot plate. |
| • **Exposure** | With usual devices for e-beam lithography.<br>☞ A typical dose to clear is about 80 - 100 µC/cm² (20 kV, resist thickness 1.0 µm). |
| • **Development** | 1-3 minutes with the developers **AR 600-55** (faster) or **AR 600-56** (slower) |
| • **Stopping** | 30 seconds with the stopper **AR 600-60** |
| • **Post bake** | For special processes 30 minutes in a convection oven at 110 °C.<br>☞ For high etching resistance in wet chemical and plasma chemical etch processes. |
| • **Cleaning** | Substrates and equipment baked < 150 °C can be cleaned with **Thinner AR 600-01** (AR-P 631-671), **AR 600-02** (AR-P 632-672), **AR 600-09** (AR-P 639-679) or **Remover AR 600-70.** |
| • **Removing** | Baked PMMA films: **Remover AR 600-70 or AR 300-70** (a stronger remover which can be heated to up to 60 °C in order to enhance effectivity).<br>☞ Hard-baked films (> 200 °C) require the use of oxidising acids (aqua regia, piranha, warm chromium sulphuric acid solutions), or a treatment with oxygen plasma. |
| • **Storage** | Functionality guaranteed for 6 months from date of sale if stored dry at a constant temperature between 10 - 22°C. |

## 4. Disposal and Safety References

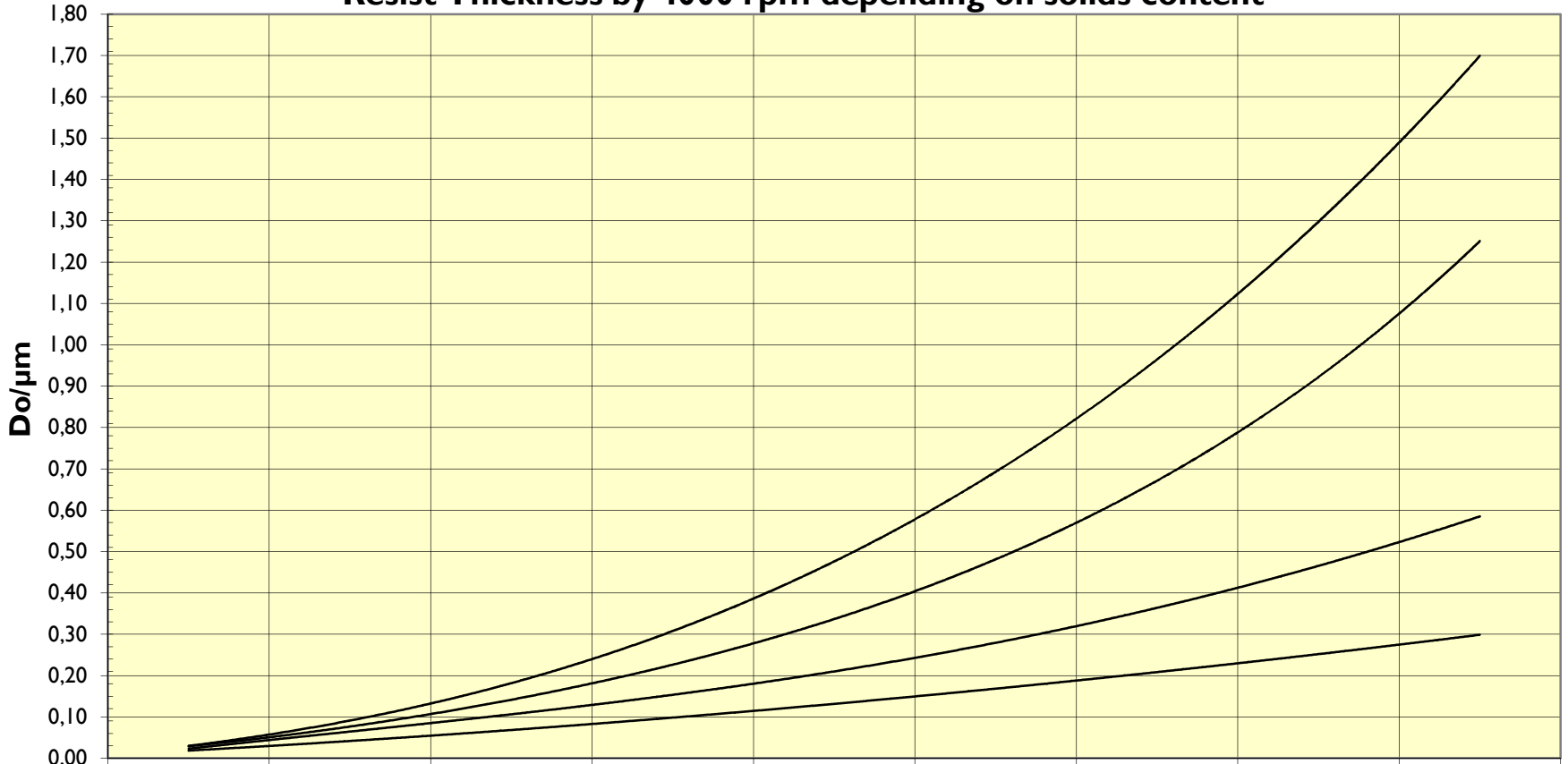
Liquid or solid wastes have to be disposed at proper deposit places or by controlled combustion in officially authorized plants. Resists and thinner contain organic solvents. Adequate ventilation in the working area is demanded. Avoid direct contact with products and their vapours.
Wear chemical goggles and protective gloves! Please ask for safety data sheets!

| Tab. 2 Spezifikations of 50K, 200K, 600K and 950K in chlorobenzene, anisole und ethyl lactate | | | | | | | | | as of 02.07.12 |
|---|---|---|---|---|---|---|---|---|---|
| **PMMA** | **E-Beam Resist** | **Solids** | **Solvent** | **Viscosity** | **Film thickness** [µm] | | | | **Density** |
| Molec.weight | **AR-P** | **content** [%] | | 25°C [mPas] | 1000 rpm | 2000 rpm | 4000 rpm | 6000 rpm | 20°C [g/cm³] |
| **50K** | 631.01 | 1,0 | chlorobenzene | 0,9 | | 0,02 | 0,02 | 0,01 | 1,104 |
| | **631.04** | **4,0** | | **1,3** | | **0,13** | **0,09** | **0,08** | **1,107** |
| | 631.06 | 6,0 | | 1,9 | | 0,23 | 0,17 | 0,14 | 1,110 |
| | **631.09** | **9,0** | | **3,1** | **0,57** | **0,41** | **0,30** | **0,25** | **1,112** |
| | 632.01 new | 1,0 | **anisole** | 1,2 | 0,02 | 0,02 | 0,02 | 0,01 | 0,992 |
| | **632.04** (new) | 4,0 | | 1,8 | 0,11 | 0,08 | 0,06 | 0,05 | 0,995 |
| | **632.06** new | **6,0** | | **2,3** | **0,21** | **0,16** | **0,11** | **0,09** | **0,997** |
| | 632.09 new | 9,0 | | 3,5 | 0,38 | 0,27 | 0,20 | 0,17 | 0,999 |
| | **632.12** new | **12,0** | | **5,1** | **0,60** | **0,42** | **0,31** | **0,25** | **1,001** |
| | 639.01 | 1,0 | ethyl lactate | 1,4 | 0,02 | 0,02 | 0,02 | 0,01 | 0,964 |
| | **639.04** | **4,0** | | **2,2** | **0,16** | **0,12** | **0,08** | **0,07** | **0,970** |
| **200K** | 641.01 | 1,0 | chlorobenzene | 1,4 | | 0,04 | 0,02 | 0,01 | 1,104 |
| | **641.04** | **4,0** | | **4,4** | | **0,23** | **0,16** | **0,13** | **1,108** |
| | 641.06 | 6,0 | | 7,9 | | 0,38 | 0,28 | 0,26 | 1,110 |
| | **641.07** | **7,0** | | **11,0** | | **0,52** | **0,37** | **0,31** | **1,110** |
| | **641.09** | **9,0** | | **17,4** | **1,13** | **0,83** | **0,59** | **0,48** | **1,112** |
| | 642.01 new | 1,0 | **anisole** | 1,9 | 0,03 | 0,02 | 0,02 | 0,01 | 0,992 |
| | 642.03 new | 3,0 | | 4,8 | 0,13 | 0,09 | 0,07 | 0,05 | 0,994 |
| | **642.04** (new) | **4,0** | | **6,8** | **0,21** | **0,15** | **0,11** | **0,08** | **0,996** |
| | **642.06** new | **6,0** | | **12,8** | **0,41** | **0,29** | **0,21** | **0,17** | **0,997** |
| | 642.07 new | 7,0 | | 16,5 | 0,53 | 0,37 | 0,27 | 0,22 | 0,998 |
| | **642.09** new | **9,0** | | **30,3** | **0,85** | **0,59** | **0,41** | **0,35** | **0,999** |
| | **642.12** new | **11,0** | | **62,3** | **1,51** | **1,08** | **0,78** | **0,63** | **1,002** |
| | 649.01 | 1,0 | ethyl lactate | 1,9 | | 0,03 | 0,02 | 0,01 | 0,964 |
| | **649.04** | **4,0** | | **5,8** | **0,25** | **0,2** | **0,15** | **0,12** | **0,970** |
| **600K** | 661.01 | 1,0 | chlorobenzene | 2,2 | | 0,04 | 0,03 | 0,02 | 1,104 |
| | **661.04** (new) | 4,0 | | 13,7 | | 0,32 | 0,23 | 0,19 | 1,108 |
| | 661.06 | 6,0 | | 28,2 | | 0,67 | 0,48 | 0,39 | 1,110 |
| | 661.08 | 8,0 | | 76,0 | | 1,29 | 0,93 | 0,74 | 1,120 |
| | **661.09** | **9,0** | | **105** | **2,58** | **1,75** | **1,25** | **1,00** | **1,113** |
| | 662.01 new | 1,0 | **anisole** | 2,6 | 0,03 | 0,02 | 0,02 | 0,01 | 0,991 |
| | **662.04** new | **4,0** | | **12,2** | **0,28** | **0,22** | **0,14** | **0,09** | **0,995** |
| | **662.06** new | **6,0** | | **31,2** | **0,59** | **0,41** | **0,29** | **0,25** | **0,998** |
| | 662.09 new | 9,0 | | 82,5 | 1,27 | 0,91 | 0,62 | 0,54 | 1,003 |
| | **662.11** new | **11,0** | | **158,8** | **2,14** | **1,47** | **1,04** | **0,88** | **1,005** |
| | 669.01 | 1,0 | ethyl lactate | 2,5 | | 0,03 | 0,02 | 0,02 | 0,965 |
| | **669.04** | **4,0** | | **15,6** | | **0,31** | **0,22** | **0,18** | **0,970** |
| | **669.06** | **6,0** | | **68,0** | | **0,74** | **0,52** | **0,42** | **0,975** |
| | 669.07 | 7,0 | | 128 | 1,66 | 1,07 | 0,74 | 0,60 | 0,978 |
| **950K** | 671.01 | 1,0 | chlorobenzene | 3,2 | | 0,04 | 0,03 | 0,02 | 1,105 |
| | **671.02** | **2,0** | | **7,3** | | **0,13** | **0,09** | **0,07** | **1,106** |
| | **671.04** | **4,0** | | **23,2** | | **0,43** | **0,31** | **0,26** | **1,108** |
| | **671.05** | **5,0** | | **57,0** | | **0,69** | **0,49** | **0,39** | **1,109** |
| | 671.06 | 6,0 | | 86,0 | | 0,97 | 0,68 | 0,54 | 1,110 |
| | 671.07 | 7,0 | | 135 | | 1,37 | 0,97 | 0,78 | 1,111 |
| | **671.09** | **9,0** | | **285** | **3,70** | **2,40** | **1,70** | **1,34** | **1,113** |
| | 672.01 | 1,0 | **anisole** | 3,8 | 0,05 | 0,04 | 0,03 | 0,02 | 0,988 |
| | **672.02** | **2,0** | | **8,8** | **0,12** | **0,09** | **0,07** | **0,06** | **0,991** |
| | **672.03** | **3,0** | | **15,5** | **0,22** | **0,17** | **0,13** | **0,10** | **0,994** |
| | **672.045** | **4,5** | | **46,2** | **0,41** | **0,32** | **0,23** | **0,19** | **0,998** |
| | 672.05 | 5,0 | | 63,1 | 0,65 | 0,45 | 0,32 | 0,26 | 1,000 |
| | **672.08** | **8,0** | | **211** | **1,65** | **1,21** | **0,87** | **0,69** | **1,005** |
| | **672.11** (new) | **11,0** | | **503** | **3,94** | **2,82** | **1,87** | **1,42** | **1,007** |
| | 679.01 | 1,0 | ethyl lactate | 3,4 | 0,05 | 0,04 | 0,03 | 0,02 | 0,965 |
| | **679.02** | **2,0** | | **7,8** | **0,12** | **0,10** | **0,07** | **0,06** | **0,967** |
| | **679.04** | **4,0** | | **43,4** | **0,63** | **0,40** | **0,27** | **0,22** | **0,970** |

The bold faced type resists of the series are standard products, their prices are included in the price list. All the other resists are delivered with a 25% added regular price in comparison with next higher solids content. With effect from 2013, Allresist will gradually replace resists in chlorobenzene by resists in anisole for health and environmental reasons. Due to our considerably extended range of anisole products with varying solid matter content, switching to anisole is already possible in 2012.

# Spezification of 50K, 200K, 600k und 950K in chlorobenzene

## Resist Thickness by 4000 rpm depending on solids content




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 631 | 0,02 | 0,05 | 0,07 | 0,09 | 0,13 | 0,17 | 0,21 | 0,25 | 0,30 |
| 641 | 0,02 | 0,07 | 0,11 | 0,16 | 0,21 | 0,28 | 0,37 | 0,47 | 0,59 |
| 661 | 0,03 | 0,07 | 0,14 | 0,23 | 0,34 | 0,48 | 0,67 | 0,93 | 1,25 |
| 671 | 0,03 | 0,09 | 0,18 | 0,31 | 0,49 | 0,68 | 0,97 | 1,30 | 1,70 |