AZ 326, 726 and AZ 826 MIF

Ready to Use
MIF Developer

Clariant

General Information

AZ 326 MIF, AZ 726 MIF, AZ 826 MIF Developers are ready to use **metal ion free developers** for use with all modern AZ Photoresists. They all are aqueous solutions of 2.38% tetramethyl-ammonium-hydroxide, which has become the standard concentration in semiconductor lithography. While **AZ 326 MIF** does not contain any additives, as requested by some users, AZ 726 MIF contains a small amount of wetting agent to provide fast and uniform build-up of the puddle. The wetting agent does not influence the lithographic performance as required for modern zero-bias photoresists. This means that the isofocal line (Bossung plot) is not shifted, independent of pattern geometries. **AZ 826 MIF** contains surfactants which also influence dissolution of photoresist. This results in faster and absolutely clean and scum-free development. Due to the higher dark erosion AZ 826 introduces a slight litho bias.

All developers are manufactured to highest standards regarding trace metal level and batch to batch variation in photospeed. Typical concentrations of Na, K, Mg, Fe and Al are below 5ppb each. Photospeed - or activity of the developer - is influenced mainly by normality (concentration) and carbon dioxide. To ensure utmost consistency we apply three different tests:

1. Precise titration for normality
Whereas the normal acknowledged precision of this analytical method is considered to be 0.3%, this by far is not sufficient to control our MIF Developers with a normality specification of

0.2610 ± 0.0005 moles/l.

We have developed a propriety method which works with an accuracy of 0.03% which in case of these developers means a tolerance less than 0.0001 mole/l.

2. Precise determination of carbon dioxide
We are able to detect 1 - 2 ppm of carbon dioxide in the developer. To ensure a content of less than 20 ppm however, requires not only measurement, but mainly a manufacturing process which avoids any carbon dioxide absorption from the atmosphere. Like any alkaline solution the developers eagerly absorb it. This also has to be kept in mind when handling them.

3. Ultra precise pH-measurement
This measurement method also is a Clariant proprietary and achieves an accuracy of $\pm$ 0.0008 pH. It allows us to measure the developer pH at its ready-to-use working concentration. It is directly related to the developer activity (on the photoresist) and includes the effect of TMAH-concentration and carbon dioxide. The following table gives the relationship between these three parameters and their influence on photospeed:

1% change in photospeed is caused by:

normality change	0.0010 mole/l	(0.0090 wt.%)
carbon dioxide	0.0005 mole/l	(22 ppm)
pH-variation	0.0010 pH	

From this it can be easily seen that by our tight specifications the worst case variation of photospeed from batch to batch will be:

normality	$\pm$ 0.0005 moles/l	=>	$\pm$ 0.5% photospeed
carbon dioxide	$\leq$ 20ppm (=10$\pm$10)	=>	$\pm$ 0.5% photospeed
together (maximum)			$\pm$ 1.0% photospeed

The pH-measurement provides an independent control of combined influence of both parameters.

Handling the Developers

To preserve these extremely tight specifications of **AZ 326 MIF, AZ 726 MIF** and **AZ 826 MIF** Developers up to the point of use some handling precautions have to be observed.

As already mentioned above, the developers, like any alkaline solution, are sensitive to carbon-dioxide absorption. For the containers we have chosen HDPE as material. It has a low permeability for gases. A completely full and sealed 5-litre bottle with developer will loose about 0.5% in activity (photospeed) within 2 years by carbon dioxide diffusion. Partially empty containers will absorb all the carbon dioxide contained in the empty volume. Assuming 1 litre of developer, 18 litres of normal air (containing 0.03% carbon dioxide) will lower the activity by 0.5%.

For these reasons the developers must never be pressurised with air, if necessary high purity nitrogen may be used. Containers should be kept well closed and, once opened, they should be used up soon.

After cleaning the equipment and associated pressure-vessels they should be well dried to avoid any dilution of the developer. 2 ml of water added to 1 litre of developer will lower its activity by 0.5%. It is also possible to rinse the system thoroughly with developer prior to filling it again.

The high quality of the developers can best be maintained when used in a closed supply system which is directly connected to the containers. As this calls for higher volume containers, we generally supply AZ x26 MIF Developers in 200 litre drums. Larger and also returnable containers are available on request. The higher ratio of volume : surface also contributes to reduced particle counts and low trace metal impurities.

Physical and Chemical Properties

Chemistry	aqueous solution of: 2.38% tetra methyl ammonium hydroxide AZ 326 without, AZ 726 and AZ 826 with surfactant
Normality	0.2610 ± 0.0005 moles/l
Carbon dioxide (typical)	≤ 20 ppm
Trace metal content (Na, K, Ca, Mg, Al, Fe, Ni, Cu)	≤ 5 ppb each
Filtration	0.1 µm absolute
Particle count (cumulative) > 0.5 µm	max. 100/ml

(tighter specifications on request, depending on container type)

Application

AZ 326 MIF, AZ 726 and **AZ 826 MIF** Developers are ready to use. They may be used with any standard and high resolution positive photoresist. The development process itself however depends on the requirement of the photoresist. Every photoresist shows optimum performance in a certain range of development time. AZ 6200B-series and AZ 6600-series perform well at 30 seconds, while AZ 7200 shows optimum performance at 52 seconds development time. These times may of course be modified to fulfil certain requirements. If high throughput is a major concern, AZ 6600 for instance may be developed within 15 sec. thereby sacrificing utmost resolution and some exposure latitude.

Standard development process nowadays is puddle development. This method ensures good reproducibility as every wafer is processed with fresh developer. The puddle may be established by a "stream" or "spray" cycle. It mainly depends on the equipment itself.

AZ 726 MIF does contain a wetting agent for fast and uniform wetting of the wafer. This helps to ensure good uniformity even on 8-inch wafers, especially when short development times are chosen.

AZ 826 MIF contains different surfactants which also have an impact on dissolution rate of photoresist. Dark erosion is higher than with AZ 726 MIF, however this helps to avoid scumming, which mainly is observed when the photoresist is processed on steppers without applying a post-exposure-bake (PEB).

The surfactant-free **AZ 326 MIF** Developer may be used with some photoresists which are designed to work with this developer type, for instance AZ 6600 and AZ 7800. It mainly depends on the philosophy of the user whether this developer is chosen. In general it's easier to set up a process with AZ 726 MIF.

Average consumption for a puddle process is 20 ml/wafer. Some non-AZ photoresists perform better with a double puddle process.

Handling Advises

Consult the **Material Safety Data Sheets** provided by us or your local agent!
Store in sealed original containers between 0°C and 35°C, prevent from freezing.
Shelf life is limited, the **expiration date** is printed on the label of every bottle below the batch number and coded as **[day/month/year]**.
AZ x26 MIF Developers are compatible with most commercially available wafer processing equipment. **Recommended materials** include PTFE, stainless steel and high-density poly-ethylene and -propylene.

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