Hi Guys,

I have no experience with ZEP, but the data sheet suggests a critical dose of ~35 uC/cm2, approximately 1/10 of PMMA. What are the problems with ZEP and under what conditions is it worth the cost? Does it last forever in storage like PMMA?

Thanks,

Long (University of Houston)

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| **#** | **Name** | **Institution** | **Answer** |
| **1** | Kevin Owen | University of Michigan | I've found ZEP is way more stable when used as a plasma etch mask; I swear PMMA etches if you look at it cross-eyed... I don't typically handle the ZEP myself, but I am pretty sure the bottle we keep in the fridge (gotta keep it in the fridge) has lasted quite a long time. |
| **2** | Orad Reshef | University of Ottawa | It does not last forever, though it DOES last after the expiration date on the label. I've heard of people decanting it on arrival and into smaller portions and freezing those, but I've never done that myself.  I think the main benefit to ZEP when compared to PMMA is its etch resistance to certain gases. The dose is sufficiently lower that if you need to write large areas it could be worth it.  You can also certainly obtain smoother features than with PMMA too, but for nearly all applications I'm not sure it's worth the price tag just for that. |
| **3** | Gustavo de Oliveira | University of Alberta | The main problem with ZEP, as I see it, is it's cost. Other than that, it's very reliable, has better contrast than PMMA for the same conditions and produces very good results, not to mention that the selectivity to plasma etch is considerably better than PMMA. As for the dose to clear, in my experience working at 10 kV and 30 kV, ZEP requires about 1/3 of the PMMA dose to clear.  Regarding shelf life, I've recently tested a batch that expired back in 2015. Patterning wise, it worked just as well as a batch that we bought at the beginning of this year.  The choice between PMMA and ZEP, at least to me, boils down to application requirements and budget. If your application requires very smooth edges, or etching a little deeper without losing much resolution and you can afford a few $1000 for 100 mL of resist, I'd work with ZEP and perhaps consider using cold development to increase contrast. Otherwise, PMMA is a very good resist in general, and you can still try cold development to improve contrast and obtain very good results. |
| **4** | Gerald Lopez | University of Pennsylvania | Many of us in the EBL community have not had issues with ZEP expiring. If the bottle cap is not secured properly, your spin curves may simply be off over time. This can be remedied by adding more solvent (anisole). Alternatively, there is CSAR 62 by [AllResist](http://allresist.de/); they will actually have a booth at the EIPBN virtual exhibition hall from June 1-4, 2021 ([www.eipbn.org](http://www.eipbn.org)) The performance is about the same as ZEP in terms of dose and etch-selectivity, and I believe is cheaper. |
| **5** | Mark Mondol | MIT | I would estimate the dose ratio between PMMA and ZEP to be closer to 4 or 5 to 1.  ZEP definitely has a shelf life, 1-2 years, maybe longer. It has much better etch resistance than PMMA.  It is expensive.  CSAR from All Resists is very similar and much cheaper, it requires about 20% more dose than ZEP. |
| **6** | Michael Rooks | Yale | The dose depends a lot on the developer. It's a tradeoff between resolution and sensitivity. You could develop ZEP in IPA/water or cold xylene for very high resolution. But then the sensitivity is closer to that of PMMA. We use CSAR instead of ZEP. It's the same polymer but a lot less expensive. Shelf life is very long - similar to PMMA. We still use a lot of PMMA, which is perfectly fine for liftoff. |
| **7** | Jean Lapointe | CNRC | It does last for years, about the same as PMMA as far as I can tell. We just finished a bottle with a 2016 expiry and saw no change after opening a new bottle.  It was stored at room T.  It can withstands plasma etching much better than PMMA but doesn’t have as good an adhesion to semiconductors. So it is not a good mask for wet etching semiconductors.  It works very well for lift-off.  It is expensive but can easily be diluted to get thinner films.  It can also be developed in N-amyl acetate; much safer than xylene and with the same contrast and dose-to-clear. |
| **8** | Noa Mazursky | Hebrew University of Jerusalem | We are using ZEP with a dose of 300 µC/cm2.  We are etching LPCVD Nitride using RIE with ~1:1 selectivity and Si with a bit higher selectivity.  I've been using an 8-year-old ZEP and it still worked well.  The disadvantage is of course the price which is not logical at all !!!!!!  The fact that a special remover is needed to strip it (N,N Dimethyacetamide) is also less comfortable.  Of course, you can always use PMMA for lift off and use a hard mask of metals/oxides for dry etching. |