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| Objective |
| Batch name: Process template |
| The objective of this trilayer resist is to be able to make very small and delicate e-beamed patterns on every type of substrate without using proximity error correction (PEC). This is in particular interesting for III-V substrates, where no good PEC exists, or for structures (on any substrate) where regular PEC is not adequate.  “What you e-beam write is what you get”.  The process has not yet been tested at DTU Danchip. In particular the dry etch of the Ge and MMA needs attention.  ZEP7000 is not yet approved to carry inside the DTU Danchip cleanroom. ZEP7000 is required, as it has a 6 times lower doe to clear than ZEP520A. ZEP520A or CSAR could with advantage be tested as well, though. |

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| Figures | | | |
| Figure | Caption | Step | Figure |
|  | Before E-beam exposure |  | ZEP7000  Ge  MMA  substrate |
|  | After E-beam exposure, development and etch (with undercut). |  |  |

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| Step Heading | Equipment | Procedure | Comments |
| 1. Preparation | | |  |
| * 1. Wafer selection | Wafer box | Take the wafers from the storage and put them in a wafer box. | Note the wafer IDs in the batch traveler |
| 1. Spin of MMA Copolymer | | |  |
| * 1. Surface treatment | BHF dip  *or*  HMDS | BHF dip for Si substrates (30 sec, H2O 5 min)  HMDS treatment for SiO2 and III-V substrates | Generally, pre-treatment is not recommended. |
| * 1. Coat wafers | Manual Spinner 1 (Laurell) | Resist: MMA  Spin: 6000 rpm (320 nm)  Softbake 15min@170 degC on hotplate | MMA is used as sacrificial layer; more sensitive than PMMA and ZEP and thus used to create undercut. |
| 1. Thermal evaporation of Ge | | |  |
| * 1. Evaporation | Wordentec | Deposit 15nm Ge  With a rate of appr. 4nm/s. Use program 27 (dedicated to Ge)  Use a Ta boat and use appr 7 pellets of Ge (this holds for at least 2 deposititons). | Step 3 should be followed by step 4 (Spincoat of ZEP) **immediately**. |
| 1. Spin coat of ZEP | | |  |
| * 1. Coat wafers | Manual Spinner 1 (Laurell) | Resist: ZEP7000 Spin: XX rpm (YY nm)  Softbake: | Note time in logbook |
| 1. E-beam exposure | | |  |
| * 1. E-beam exposure | E-beam writer | Dose: appr. 350 muC/cm2  Use no proximity error correction (PEC). | Write the finest structures (20 nm range) twice with half dose each to avoid resist heating. |
| 1. Development | | |  |
| * 1. Develop-ment | Petribowl | Develop with Hexyl Acetate, preferably in MegaSonic agitation at power X W. Develop 30s.  Blow dry with N2 after development. | Megasonic necessary for small structures |
| 1. Ge Dry Etch | | |  |
| * 1. Ge Etch | ICP Metal Etcher | Run a low-pressure CF4 etch.  Rate is X nm/min. | Use a sapphire carrier |
| 1. MMA dry etch | | |  |
| * 1. MMA dry etch | ICP Metal Etcher | For small undercuts, use low-pressure plasma (O2 with appr 20% Ar) to etch vertically to the substrate.  An isotropic etch (undercut) can be done with pure O2 plasma etching. |  |
| * 1. SEM inspection | SEM-Zeiss | Measure linewidths | Note on measurement sheet |
| 1. Lift-off (after evaporation or etch) | | |  |
| * 1. Trilayer lift-off |  | Heated acetone/1165 |  |