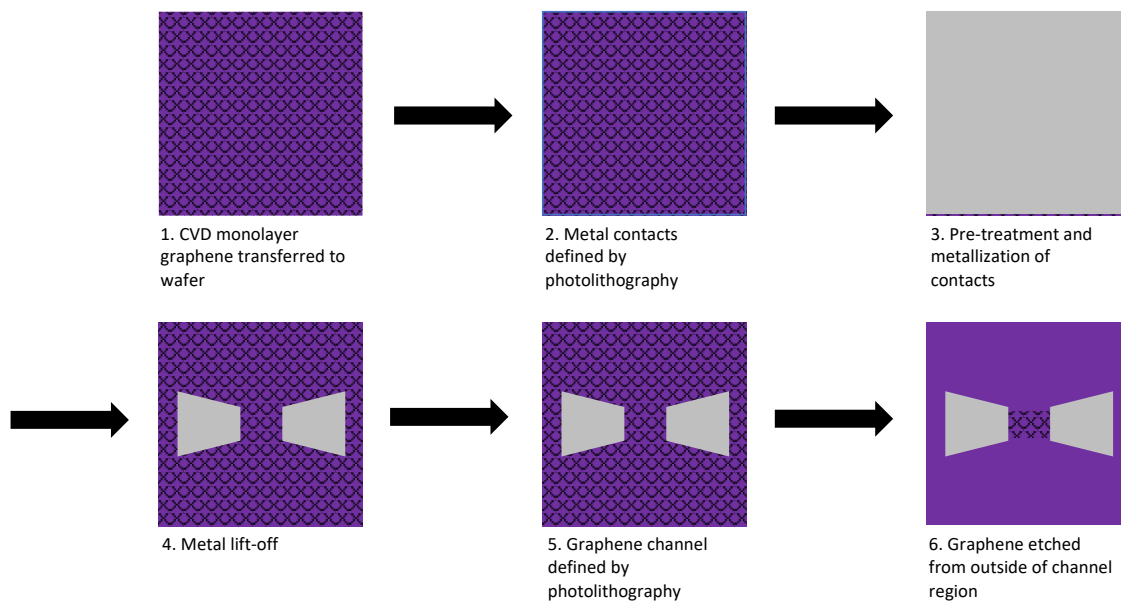


GRAPHENE FOUNDRY SERVICES: GUIDELINE

PROCESS FLOW

Graphenea's Graphene Foundry Services include the following processing steps:

- Graphene transfer onto the target substrate
- A two-step lithography process: Ni/Al edge contact patterning and graphene patterning, as specified on the scheme below
- Dicing of the wafer (if requested)



SUBSTRATE REQUIREMENTS

- Maximum allowed substrate diameter is 6".
- Minimum substrate thickness is 100 μm .
- Graphenea can provide 4" and 6" Si/SiO₂(90nm) substrate (B-doped Si, resistivity: 1-10 $\Omega\cdot\text{cm}$, 675 μm thick). Any other substrate should be provided by the customer.
- Substrate should not contain any Au structure.

The customer substrate should be compatible with various microfabrication processes, which include the following:

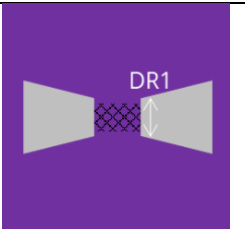
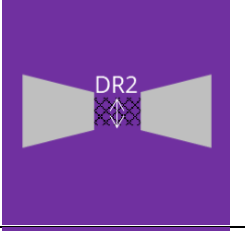
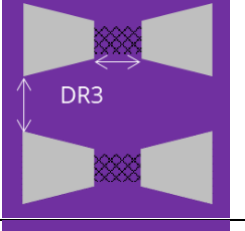
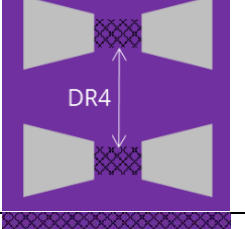
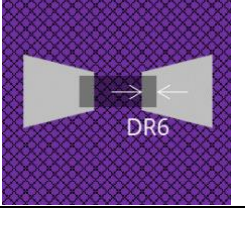
1. Compatible with solvents including acetone, isopropanol, water
2. Compatible with developers based on tetramethylammonium hydroxide
3. Compatible with annealing temperatures of 300 °C in inert environment
4. Compatible with baking temperatures on a hotplate of up to 200 °C in air
5. Compatible with exposure to oxygen plasma

DESIGN RULES

The client is requested to design the layout according to the design rule specifications in this document. Failure to adhere to these design rules may result in unsuccessful GFET fabrication, a reduction in yield or in reduced device performance.

Alignment marks are required to be included in the client's design according to the specifications below. The design should also contain some test structures for Graphenea's quality control, also specified in this document.

Designs should be approved by both the client and Graphenea before mask designs are submitted for manufacture.

#	Design rule		
DR1	Minimum feature size – metal	5 μm	
DR2	Minimum feature size – graphene	5 μm	
DR3	Minimum feature separation – metal	5 μm	
DR4	Minimum feature separation - graphene	5 μm	
DR5	Minimum graphene-metal overlap	5 μm	
DR6	Mask alignment accuracy	3 μm	

Alignment mark patterns

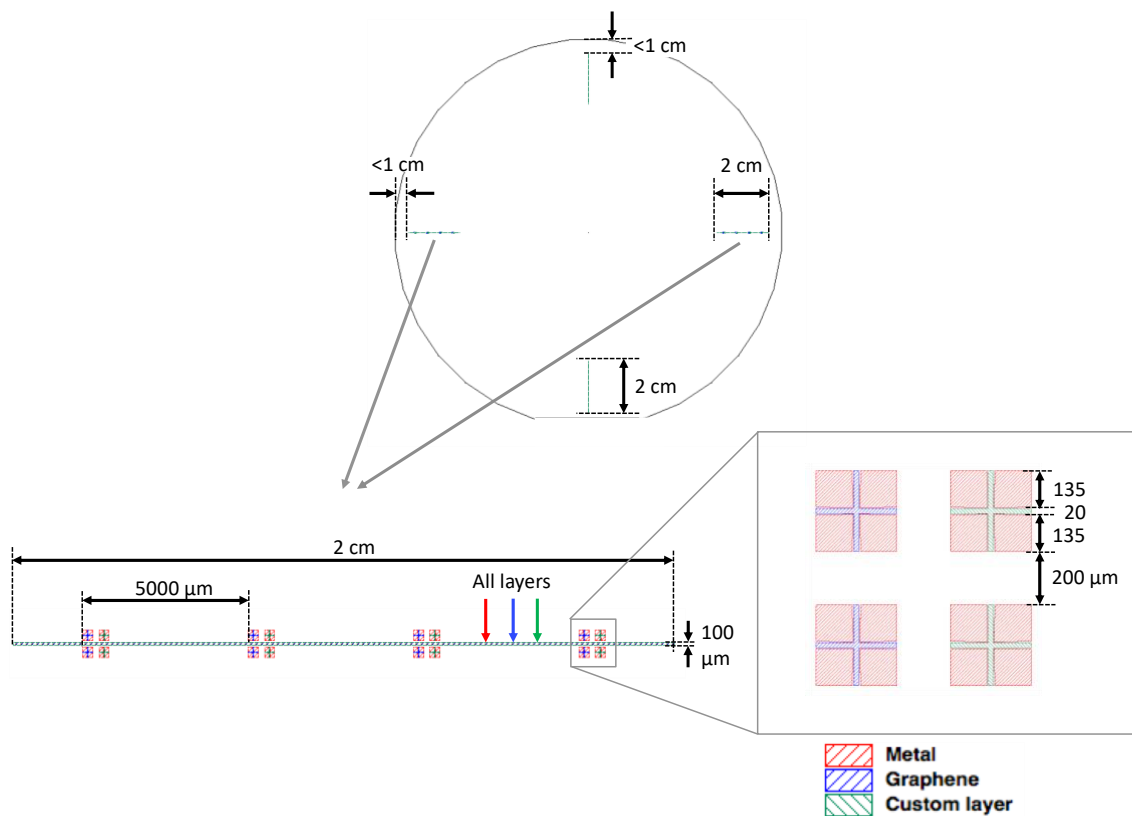
Three layers are included in this alignment mark pattern:



The alignment mark patterns should be included on the top-bottom and left-right of the wafer, as indicated on the image, regardless of the wafer size (4" or 6").

Both vertical and horizontal lines are 100 μm wide and 2 cm long, and should be placed no further than 1 cm from the wafer edge. Horizontal lines should be parallel to the wafer flat. All layers (metal, graphene, and custom layer if applicable) should include these lines.

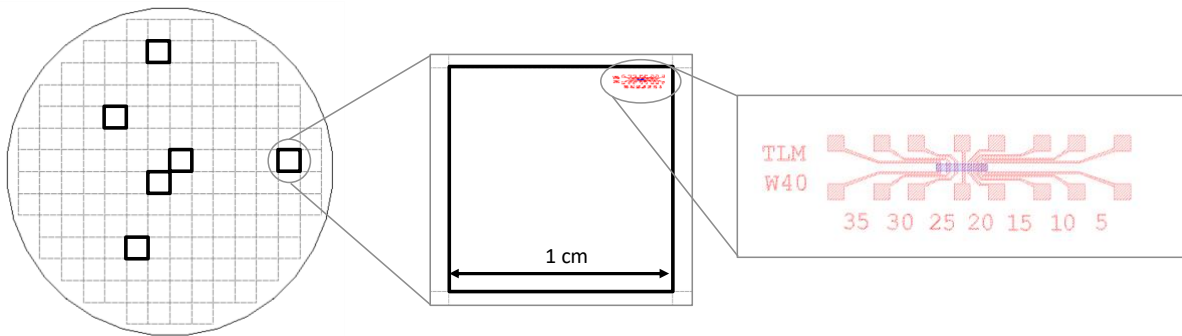
In addition, horizontal lines should include some alignment marks next to it, as indicated on the images. There will be 4 sets of alignment marks on each side, with 5000 μm pitch size.



If the customer provides a wafer with alignment marks (green coloured structures on the schemes above), these should be clearly visible on the substrate for subsequent alignments.

Test structures

The layout should include some structures for transmission line method (TLM) for Graphenea's quality control. The image below shows an example for 6" wafer and 1 cm dies: TLM structures are included on the bolded dies, on the upper right corner. Right image shows details of the TLM structure (sizes indicated in μm -s). The amount and position of the TLM structures should be kept similar to the example image, however, small variations are allowed if the structures overlap with other features in the layout.



Alignment marks and test structures are included on GDS file on the website, which can be downloaded: "Graphenea-GFab_Design_Template.gds".

MASK SPECIFICATION

Masks can be printed by Graphenea or customer. For a 6-inch wafer, the mask should be 7-inch and made of quartz. The thickness should be around 3 mm, never below 2.5 mm.

TECHNICAL SUPPORT

If you have any queries during the design process, please contact info@graphenea.com.