

GRAPHENE

Fact Sheet
Technology

Graphene, a monolayer of sp^2 -bonded carbon atoms is a new material for various applications in the field of micro- and optoelectronics. These applications range from components for microelectronics to functional coating and up to applications in medicine. AMO GmbH, as a specialist for research services in the field of micro- and optoelectronics, provides customized solutions for each field of application, however focusing on microelectronic components for applied research as well as basic research.

SOLUTIONS

AMO GmbH offers solutions adapted to your demands for different fields of application with the following product portfolio:

Graphene Flakes	Mechanically exfoliated graphene-flakes ideally fit for applications in fundamental and applied science where highest crystalline quality is required and a low crystallite size can be accepted.
Graphene Devices	AMO offers the fabrication of graphene transistors and can also support your own process development as part of its graphene foundry services.
Catalytic Graphene	Catalytically produced graphene is appropriate for all areas in which large-scaled graphene is needed, such as transparent electrodes or functional coatings.
Substrates	AMO offers different custom-made substrates to facilitate your research with graphene.

■ Graphene Flakes

AMO's graphene flakes are made of natural graphite by mechanical exfoliation. The substrates consist of highly doped silicon wafers which can be coated with numerous dielectrics. The characterization of substrates by AFM and CV measurements as well as the characterization of flakes by Raman spectroscopy belong to AMO's range of services. Individual adaptations are possible.

	Thickness of Dielectrics nm	Chip Size	Flake Size	Alignment Mask
SiO ₂	90 or 300	Diced according to your requirements or whole wafer 1"-6"	5-150 μ m edge length	Markers for E-Beam Lithography, standard layout or according to customer specification
Al ₂ O ₃	72			
Ta ₂ O ₅	65			
HfO ₂	65			
Gd ₂ O ₃	75			
Functionalization with HMDS	~1			

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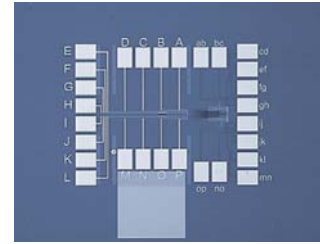


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■ Graphene Devices

Graphene field effect transistors (GFETs) have been fabricated and characterized by AMO since 2005. For our standard GFETs exfoliated graphene on thermally oxidized silicon is used. The electrical contacts are fabricated by contact lithography and sputter deposition of nickel using the lift-off process. The highly doped silicon substrate with the thermal oxide layer is used as back-gate for control of the charge carrier density. Besides, a wide spectrum of further CMOS typical process technologies and materials is available in our cleanroom. This allows the fulfillment of nearly any customer requirement.



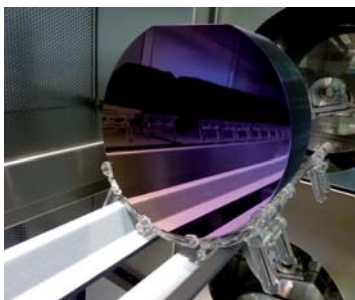
Substrate	Graphene Structuring	Metals for Contacts and Gate	Lithography Procedure	Dielectrics e.g. for Top Gate
See Substrate	Unstructured Graphene Flakes	Nickel	Optical Lithography: Min. structure with >1µm	Al ₂ O ₃
Substrates can be sawn to the required size: 3*3 mm ² - 6" wafers	Structuring with oxide plasma and lithographical etch mask	Titan/ Gold	E-Beam Lithography: Min. structure widths >50 nm	SiO ₂
		Wolfram		

■ Catalytically fabricated graphene

The catalytic effect of transition metals such as nickel or copper enables the growth of graphene on metal surfaces by using appropriate carbon sources and process parameters. AMO GmbH fabricates graphene on nickel layers by using solid carbon sources. The starting substrate is a thin nickel layer on thermally oxidated silicon. The graphene is polycrystalline with an irregular number of graphene layers ranging from one monolayer up to 10 layers. Substrate sizes are available between 3x3 mm² and 4" wafers.

■ Substrates

You want to fabricate your own graphene pattern? At AMO you can order customized substrates without graphene. Many diverse materials, manufacturing processes and substrate sizes are available. Substrates can be ordered from 3x3 mm² up to 6" and starting from a single chip to larger batches. Standard sizes are 2x2 cm² and 6". Additionally, alignment marks can be etched into or metalized onto the substrates.



	Thermally grown	sputtered	ALD	evaporated	Alignment Marks
SiO ₂	o	x		x	10 x 10 µm ²
Al ₂ O ₃		x	o	x	Maker size
HfO ₂		x			1 x 1 mm ²
Ta ₂ O ₅		x		x	Area size
Gd ₂ O ₃				x	SiO ₂
		x = available		o = recommended	

Please contact us for larger amounts or individual adaptations.

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