

A close-up photograph of several hands of different skin tones clasped together in a supportive grip. The hands are positioned in the upper right and center of the frame. Overlaid on the image is the text "Sweden loves Graphene" in a bold, yellow, sans-serif font. The text is arranged in two lines, with "Sweden loves" on the top line and "Graphene" on the bottom line, both slanted slightly upwards from left to right. The background is a soft, out-of-focus blue and white, suggesting a sky or a bright indoor setting.

Sweden loves
Graphene





GRAPHENE WEEK 2023

TURN WONDER INTO ACTION

#GW2023

GRAPHENE
WEEK

TURN
WONDER
INTO
ACTION



supported by
European Union



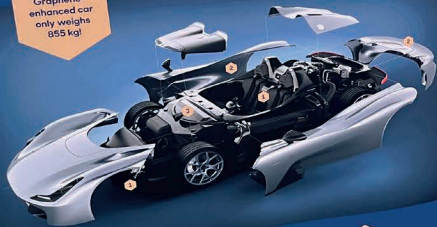
GRAPHENE
FLAGSHIP

GRAPHENE SPORTSCAR

Featuring graphene-enhanced body
and fire-resistant interior

Manufactured by Dallara Automobili Spa, this car
showcases components consisting of three kinds of carbon
fibre composites with epoxy resin enhanced with graphene,
leading to improved physical properties.

Graphene-
enhanced car
only weighs
855 kg!



1

The graphene-based
composite used in the car's
floor does not burn or
deform.

2

Graphene in the lateral
and rear panels
facilitates dissipation
of vibrations and
oscillations.

3

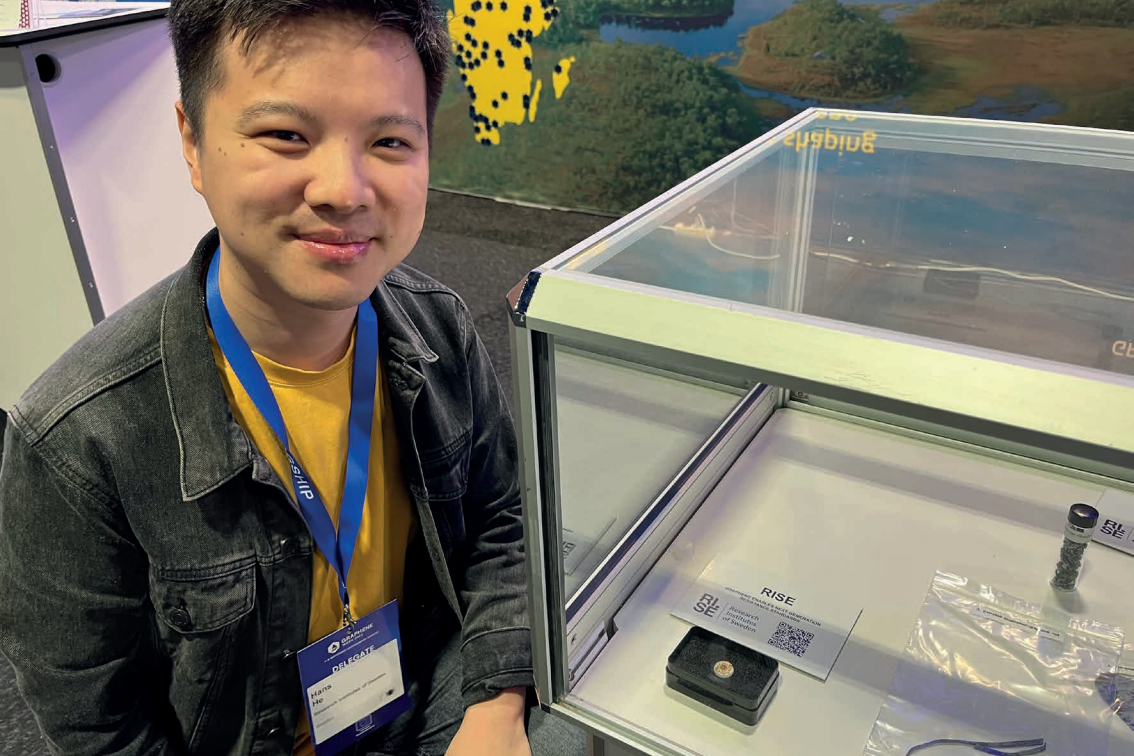
Graphene-enhanced
composites in the front
structural panel improve
the car's ability to resist
deformation under load.



Sweden loves
Graphene







DELEGATE
Hans He
International Institute of Management
University of Bremen

RISE
Research
Institutes
of Sweden
QR CODE




RISE
Research
Institutes
of Sweden



THE GRAPHENE FLAGSHIP

*"FET Flagships are ambitious large-scale, science-driven, research initiatives that aim to achieve a visionary goal.
The scientific advance should provide a strong and broad basis for future technological innovation and economic exploitation in a variety of areas, as well as novel benefits for society."*

- 10 year initial project period (start October 1, 2013)
- 1,000 M€ project cost (500 M€ from EC; thus far spent 400 M€)
- Over 170 partners in over 20 countries, evenly divided between commercial companies and non-profit organizations (universities and research institutes), plus 213 Associate Members across Europe
- Many of the Graphene Flagship activities will continue beyond the initially planned project period





GRAPHENE
FLAGSHIP

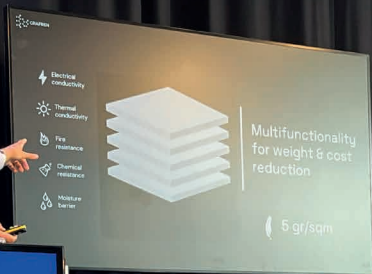
STANDARDISATION

anekdotische Entwicklung

2002 2044 (1,184)

Type A Type B Type C Type D Type E Type F Type G Type H Type I Type J Type K Type L





Erik Khranovskyy
Grafren

GRAPHENE
WEEK

TURN WONDER
INTO ACTION


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TURN
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ACTION



Together we are shaping
the future of Graphene
and 2D materials



Anna Carlsson
Bright Day

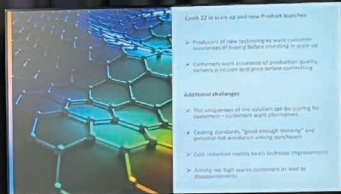
**GRAPHENE
WEEK**

TURN WONDER
INTO ACTION

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Graphene Week 2023

- Products of new technology want customer acceptance of buying before investing in scale-up
- Customers want assurance of production quality before production and prior to scaling

Additional challenges

- The uniqueness of the solution for the scaling to customers - customer want alternatives
- Creating standards, "good enough" and personal and individual among customers
- Cost reduction enables better technical improvements
- Attracting and retaining customers in need of transformation



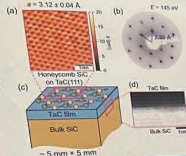
ambient by monolayer SiC and graphene. This novel material exhibits superconducting properties and long-term stability, making it a promising candidate for quantum technologies.

Encapsulated TaC: surface science

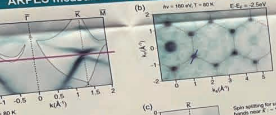
nm thick epitaxial
ter deposited on
strates and
 $T = 1700^\circ\text{C}$ [1].

ng microscopy (STM)

electron diffraction (LEED)
section of sample structure.
high-angle annular dark-
transmission electron
AADF STEM)



ARPES measurements: spin-split surface states



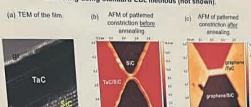
ARPES band structure.
constant-energy surface through the
constant-energy surface (pink line in (a)).
Dirac-like crossing of surface states
ARPES measurement of surface states
blue line in (b)).

Identification of monolayer honeycomb silicon carbide

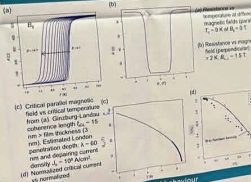


Graphene-encapsulated TaC: transport

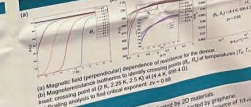
Bottom-up growth of graphene [2] is combined with patterning of TaC films (epitaxy within devices). The graphene/TaC films can also be patterned after annealing using standard EBL methods (not shown).



Superconducting properties



Quantum critical behaviour



Conclusions

We have shown that annealing of TaC films sputter-deposited onto SiC is a method to synthesize large-area high-quality TaC films protected by graphene. Top-down patterning of as-deposited TaC films followed by annealing results in all-silicon nanowires, down to 50 nm wide, of TaC with surface protected by graphene. The superconducting properties of the graphene/TaC films make them promising for quantum devices, because graphene encapsulation alleviates the oxide (source of 1/f-noise) common to most superconducting films.

[1] C. M. Patten, H. Felderwitz, T. Balasubramanian, A. A. Zakharov, R. Yakovlev, D. Bickel, J. Krasov, S. P. Dash, S. Kulkarni, and V. Lora-Avila. Bottom-up growth of monolayer hexagonal SiC. *Phys. Rev. Lett.* 130:086101, Feb 2023.

[2] C. Virostnik, M. S. Gopinath, R. Yakovlev, L. J. Lau, A. A. Zakharov, and T. Balasubramanian. Synthesis of large area graphene layer growth on SiC. *ACS Nano*, 7(8), 12 2013.

Review in: *Condensed Matter and Materials Physics*, vol. 78, no. 24, 12 2019.

2D-TECH
MAX IV

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MC2
Materials for Quantum Technologies

Area of Advance
NANO

CHALMERS
UNIVERSITY OF TECHNOLOGY

DELEGATE



Hall
H

GRAPHENE
FLAGSHIP

Collaborate
with us!

Standardisation -
Enabling 2D materials
in industry

WHAT STANDARDS

WHAT STANDARDS
Vocabulary

The 2D graphene
Sweden in Graphene
Graphene Forum





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Poster nr. 91

Development of a method for exposure- and risk assessment of graphene.

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- ²Occupational and Environmental Medicine, Sahlgrenska University Hospital, Gothenburg, Sweden
- ³Materials and manufacture, Chalmers university of technology, Gothenburg, Sweden

Background

Graphene has many useful properties. The toxicity, however, has yet to be determined.

Today there are no standardized tools to measure graphene in workplace air. Thermal optical analysis (TOA) is a standardized tool that is used to measure diesel exhaust exposure by measuring elemental carbon (EC).

Purpose

Investigate the possibility to use thermal optical analysis as a standardized tool for air exposure measurements of graphene and its derivatives, to use it as a tool for exposure and risk assessment of graphene.



Figure 1. Graphite nano platelet diluted in water.

Method

TOA is a method where the samples collected on quartz fibre filters are heated according to a pre-determined protocol. The filter is first heated in a He atmosphere and then in a He-O₂ atmosphere. The EC will leave the filter in the He-O₂ phase and be detected with a flame ionisation detector (FID).

Results

In figure 2 the analysis of different graphite and graphene derivatives is observed. Clear differences in emission temperatures can be seen between the different materials.

In figure 3 the results from an air measurement at a graphene producer can be observed. Similarities in emission temperature can be seen between air samples and graphene material.

Take home message

Thermal optical analysis is a possible method for studying graphene exposure.

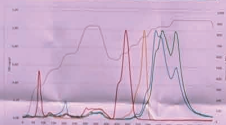


Figure 2. (—) GO, (---) rGO2, (---) GNP 2 and (---) GNP 1 and (---) is the temperature. Results from the analysis of two graphite nanoplatelets materials (GNP), one graphene oxide (GO) and one reduced graphene oxide (rGO). All signals received from the FID has been normalized to a 0 to 1 scale to easier be able to compare the differences.

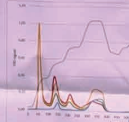


Figure 3. (---) Person 1, (---) Person 2, (---) Background and (---) is the temperature. Results from the analysis of two persons measurements from graphene producer and one background measurement.

Conclusion

Thermal optical analysis appears to be a possible method to quantify and analyse graphene exposure. There also some indication that TOA can be used to differentiate between different graphene materials. More research is needed.

GRAPHENE FLAGSHIP

SIO
GRAFEN



What is SIO Grafen?

One of Sweden's 11 strategic
innovation programs

At our sector Sweden is one of the
leading countries in developing and
using 2D materials industrially

Sweden loves
Graph





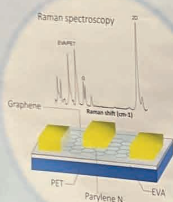
High mobility graphene field effect transistors on EVA/PET

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Department of Microtechnology and Nanoscience, Chalmers University of Technology, 412 96 Göteborg, Sweden

Introduction

Scalable, and cost-efficient technology to fabricate high mobility graphene field-effect transistors (GFETs) remains challenging even to this day. Here, we report a highly scalable surficial layer free fabrication method of flexible graphene field-effect transistors. We use Poly(ethylene terephthalate) (PET) as a dielectric. At room temperature, we measure charge carrier mobility in the range of $5000-8000 \text{ cm}^2/\text{Vs}$. We demonstrate the long-term stability with minimum hysteresis of such GFETs. The resulting monolayer towards additional lithography steps enable vertical device integration of graphene for multi-stacked electronics fabrication.



Conclusion

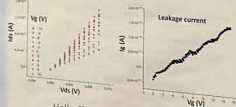
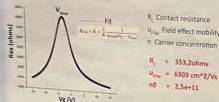
1. Fabricated GFETs show excellent transport properties.
2. Field effect mobility was extracted using the fitting method proposed by Kim et al. APL 94, 06217, 2009
3. High hall and field effect mobility is reported for an extremely scalable and economic method.
4. Minimum hysteresis and very low leakage current is reported in fabricated GFETs.
5. Quantum hall effect observed in prepared devices validates the excellent transport properties.

Experimental

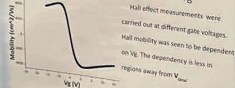
1. Graphene synthesis was carried out by low-pressure CVD.
2. Source drain pads were fabricated on EVA/PET by standard photolithography.
3. CVD graphene on copper was laminated to EVA/PET with source drain pads.
4. Poly(ethylene terephthalate) (PET) was deposited using CVD method.
5. Gate electrode was patterned using standard photolithography and metal evaporation.

Results

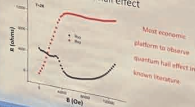
Field effect measurements



Hall-effect measurements vs Vg



Quantum hall effect



Most economic platform to observe quantum hall effect in known literature





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