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TERAHERTZ METADEVICES WITH CARBON NANOMATERIALS

Ineta Grikalaite[1], Alexander N. Grebenchukov[2], Anton D. Zaitsev[2], Mikhail K. Khodzitsky[2], Ana I. S. Neves[1] and Anna Baldycheva[1]
[1]Centre for Graphene Science, College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter, EX4 4QF, UK
[2]Terahertz Biomedicine Laboratory, ITMO University, Saint Petersburg, 199101, Russia

EPSRC Centre for Doctoral Training in Metamaterials
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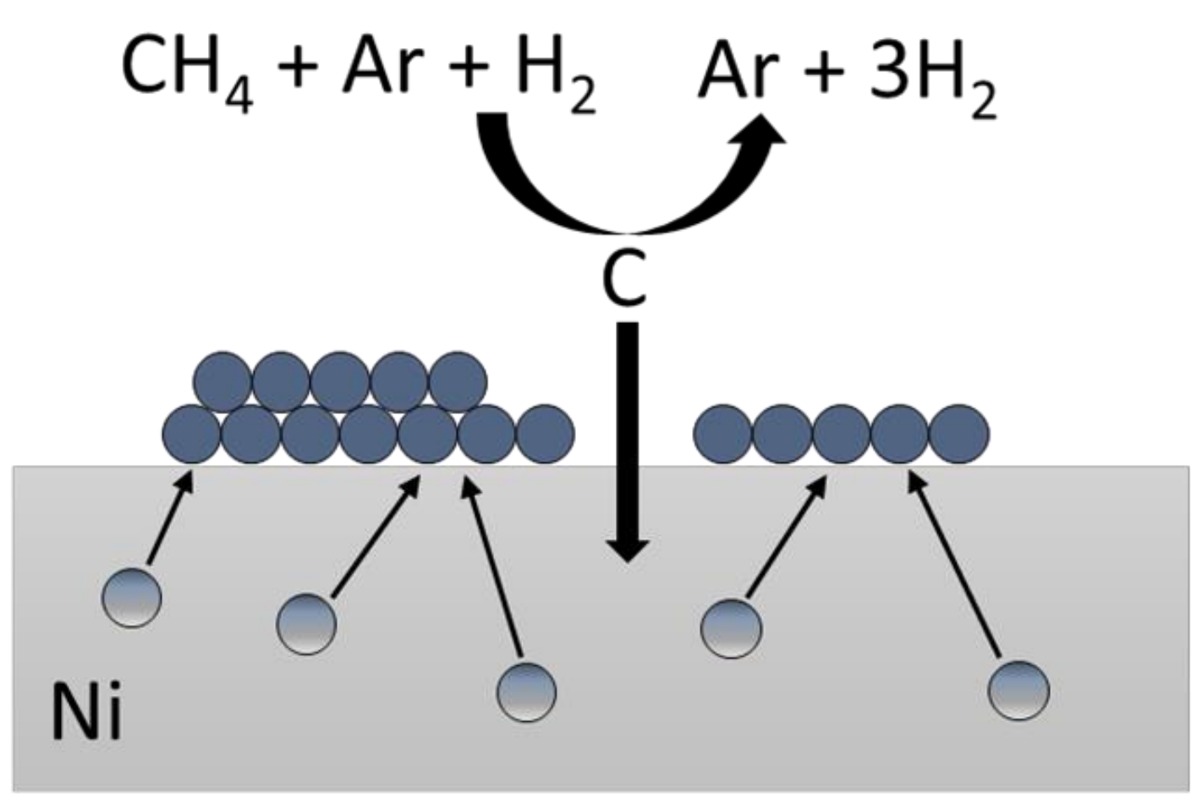
Terahertz technologies have gained a substantial interest due to their potential applications in different sectors such as security, quality control, information and communications, biology and medical sciences, and others [1]. However, the technology for generating and manipulating terahertz radiation is still in its infancy. The use of graphene-based materials has already been proposed [2, 3]. Our goal is to fabricate metasurfaces based on **multilayer graphene (MLG)** films on flexible substrates for manipulating terahertz radiation. This includes developing a production method for multilayer graphene films of controlled thickness, optimisation of multilayer graphene film transfer onto target substrates and engineering metasurfaces by means of photolithography.

GROWTH

Chemical Vapour Deposition (CVD) + nickel catalyst → Large-area and high-quality MLG

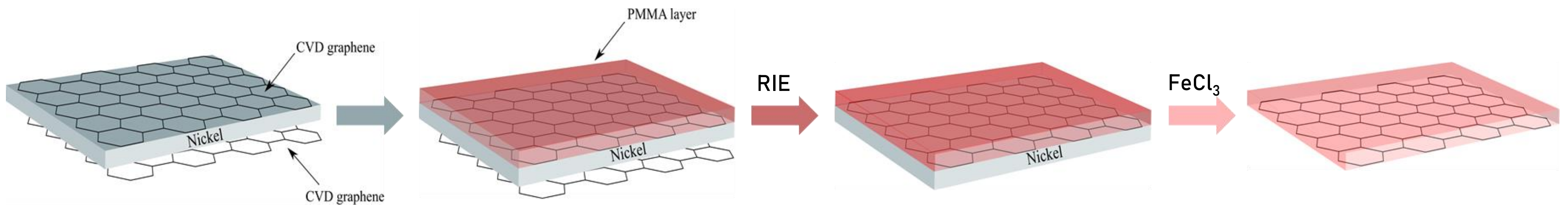
Controlling the number of graphene layers:

- Substrate thickness
- Pressure (APCVD, LPCVD)
- Temperature (850-1050 °C)
- Gas flow rate
- Residence time of the carbon source
- Cooling rate

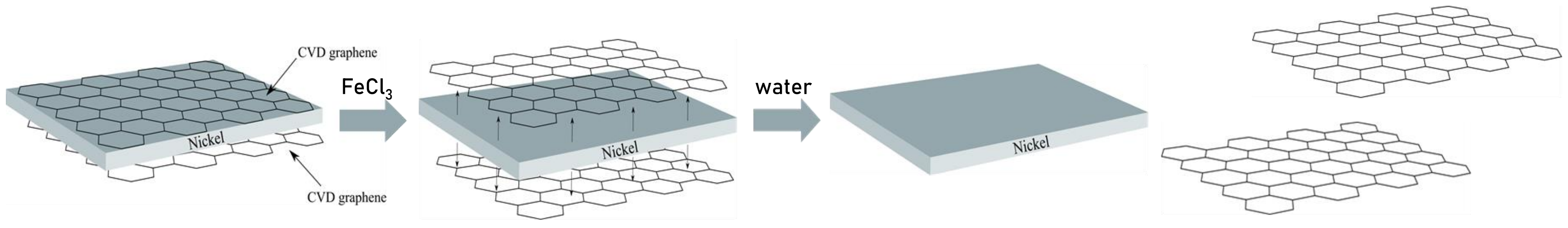


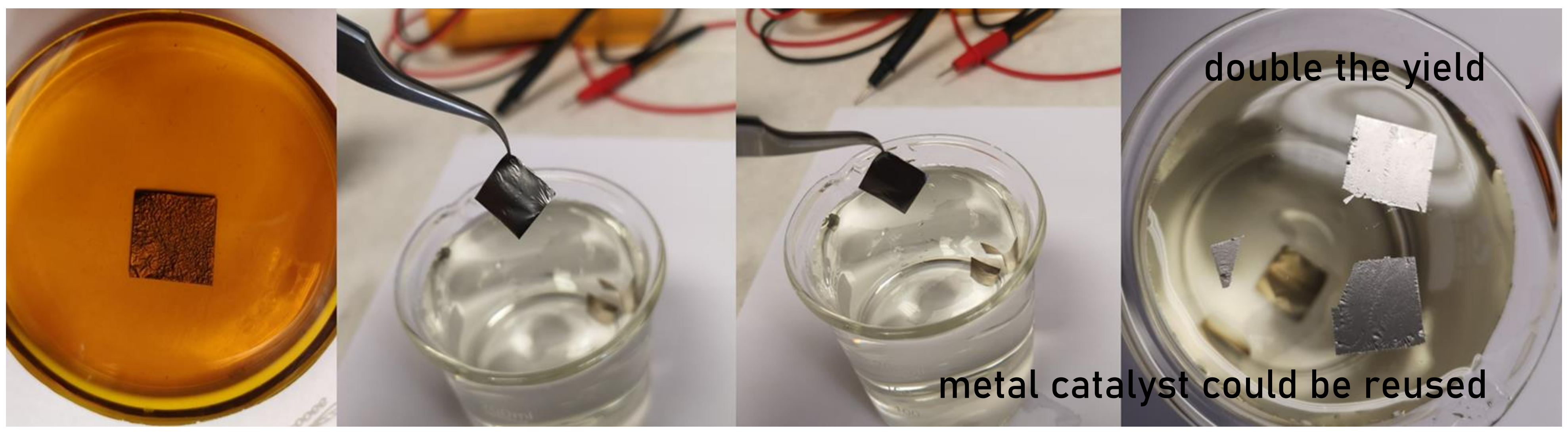
TRANSFER

Typical wet graphene film transfer



Modified wet graphene film transfer



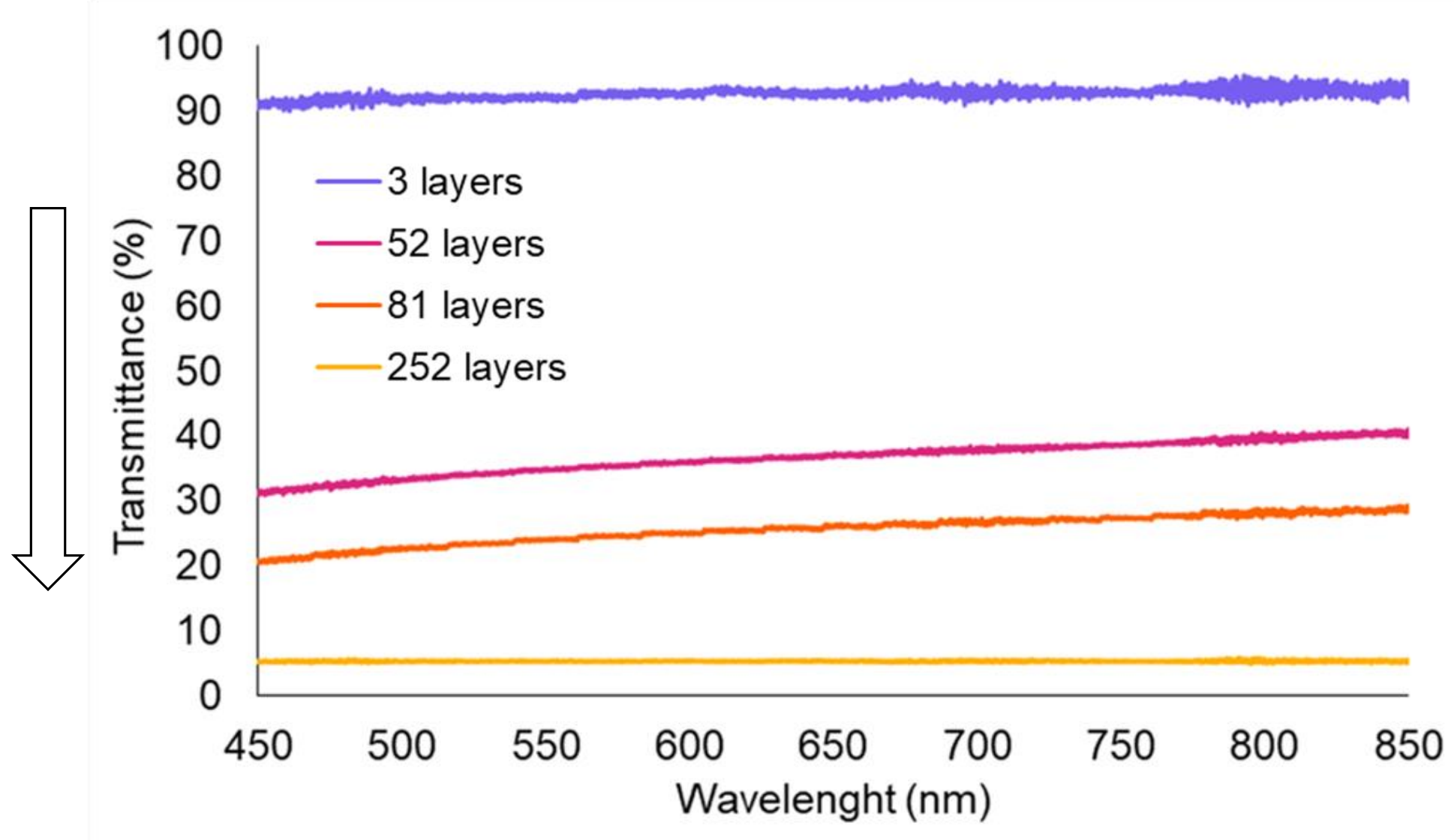


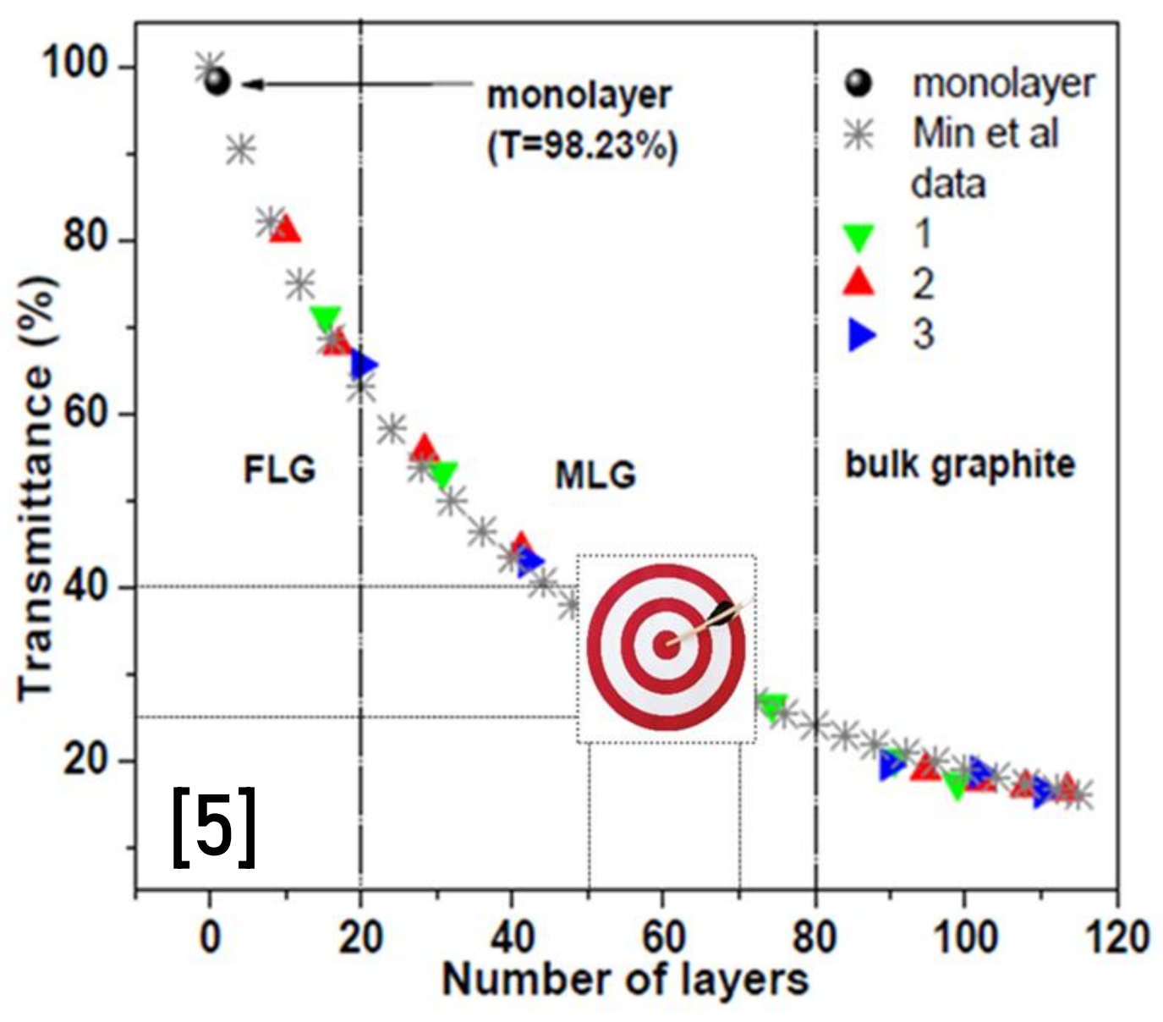
OPTICAL TRANSMITTANCE

For MLG the optical transmission is directly dependent on the optical conductance of the graphene stack and the optical transmittance [4].

$$T(\omega) = (1 + \underbrace{f(\omega)}_{\text{1.13 at 550 nm}}\pi\underbrace{\alpha}_{e^2/\hbar c \approx 1/137} N/2)^{-2}$$

Obtained optical transmittance data:





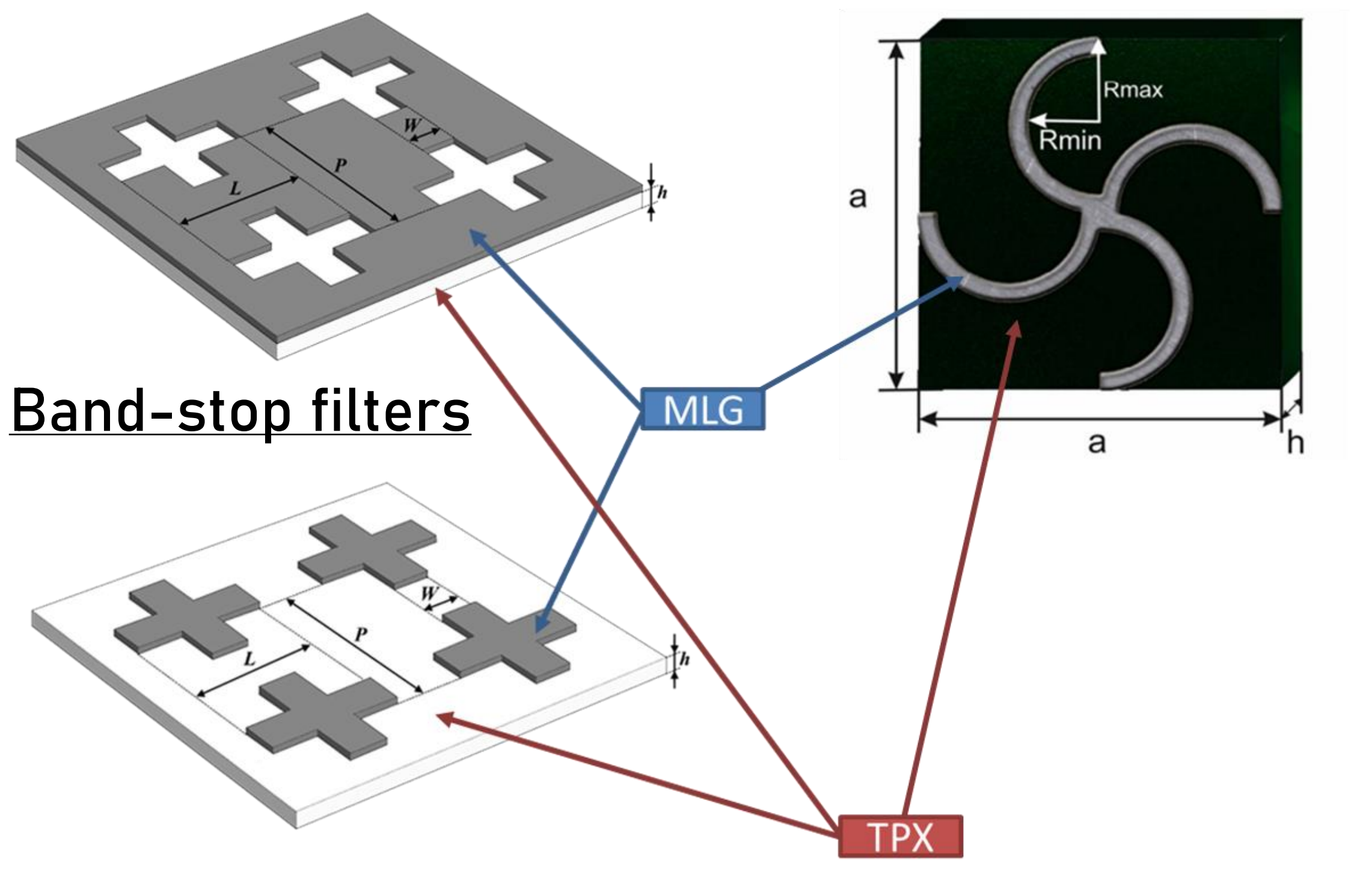
TERAHERTZ METASURFACES

The interaction between terahertz waves and MLG could be further enhanced by engineering periodic subwavelength sized patterns – metasurfaces [6].

Band-pass filters

Chiral metasurfaces

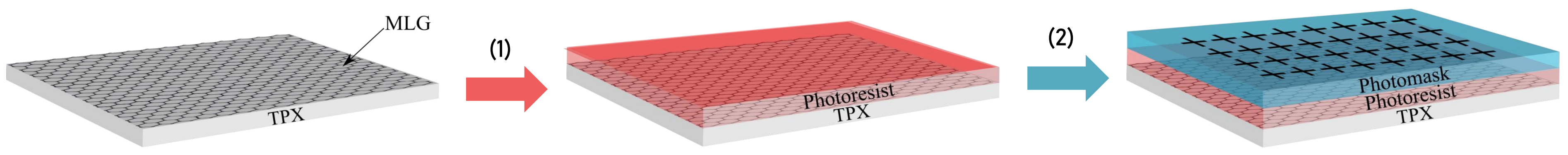
Band-stop filters

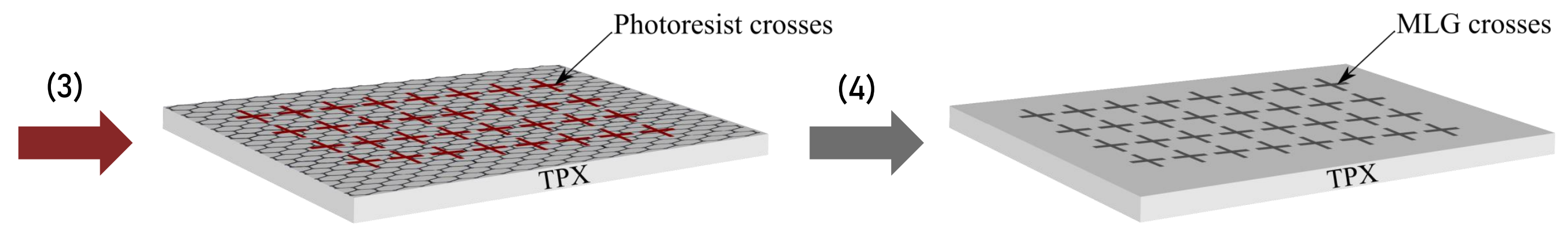


Resonance frequencies
100-950 GHz;
Band-pass range 40 GHz

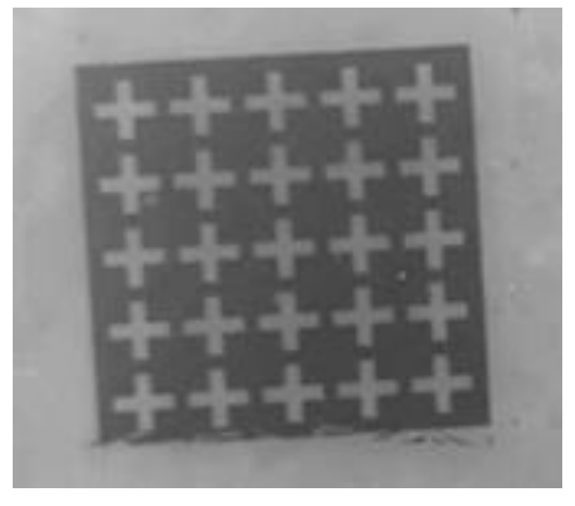
TPX© – polymethylpentene:
- Optically transparent in UV, visible and THz ranges
- Heat resistant
- Chemical resistant
- Flexible

FABRICATION





Real image

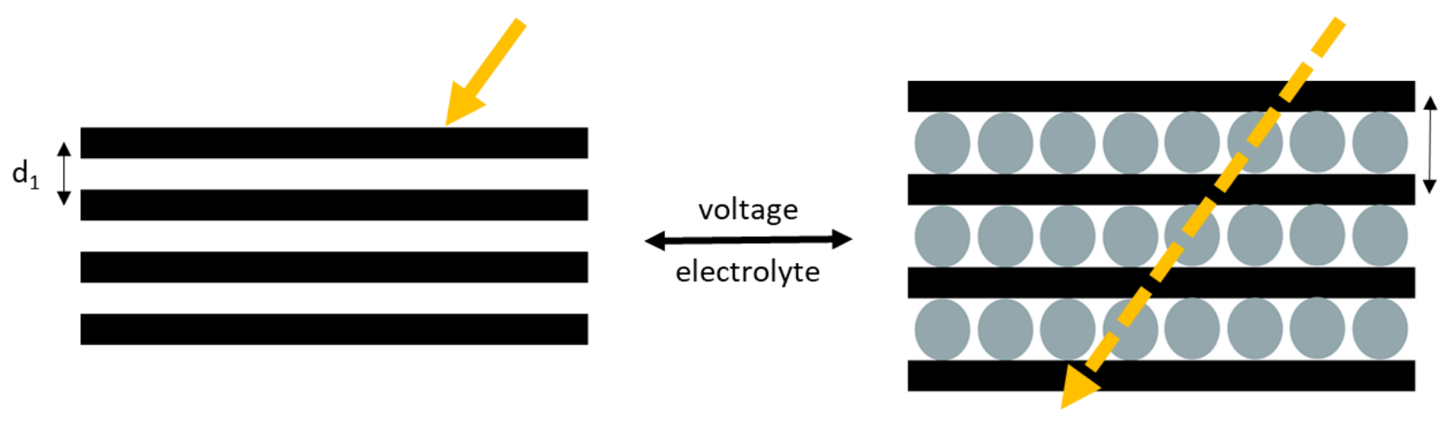


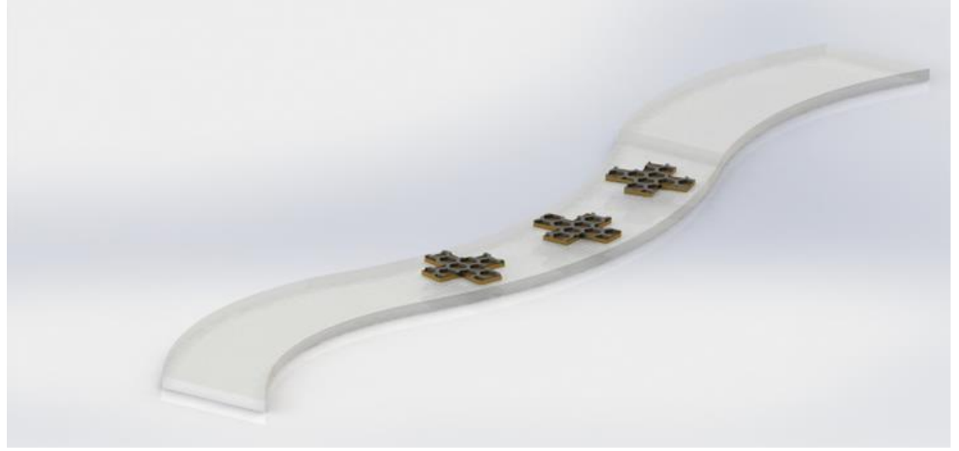
1 cm

Photolithography: (1) spin coat photoresist, (2) apply photomask, (3) expose to UV light and develop a photoresist pattern, (4) etch the unprotected MLG with Ar/O_2 plasma to produce a desired MLG pattern.

FUTURE WORK

- Fabrication optimisation and testing of MLG-based metasurfaces for biophotonics applications
- Fabrication of MLG-based optical modulators with switchable transparency in THz range
- Textile substrates with graphene metasurfaces for wearable THz communication applications





CONTACT PERSON

Ineta Grikalaite
UNIVERSITY OF EXETER

ig292@exeter.ac.uk
ex.ac.uk/ig292
www.exeter.ac.uk/metamaterials

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Acknowledgments

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