Solar Energy for a Decarbonised Future - Knowledge Transfer for Environmental Education and Awareness (SolAware)

Summer training 2023- 2024
First week- Session 1 and 2

Dr. Ahmed Suhail

A Project Funded by the British Council Between University of Mosul & Teesside university on Research Environment

Activities and outcome of this training

A1- Develop a curriculum for solar training.

A2- Develop the educational materials and hands-on lab activities.

A3- Identify participating students.

A4- Develop a virtual learning process for the manufacturing of solar cells. This includes complete sessions for each step of the fabrication process.

A5- Set up a large solar system and measure its characteristics.

Outcomes:

O1- A culture of sustainability from an early age and solar technology integration into academic programs.

Provide solar training to students at Mosul University.

The first week of Summer training

- Session 1 (Introduction to solar technology, clean process and Lithography in the clean room) on the 1st of July at 10:00 am via Microsoft Team.
- Session 2 (Sputtering and Wet transfer process) on the 3rd of July at 10:00 am via Microsoft Team.

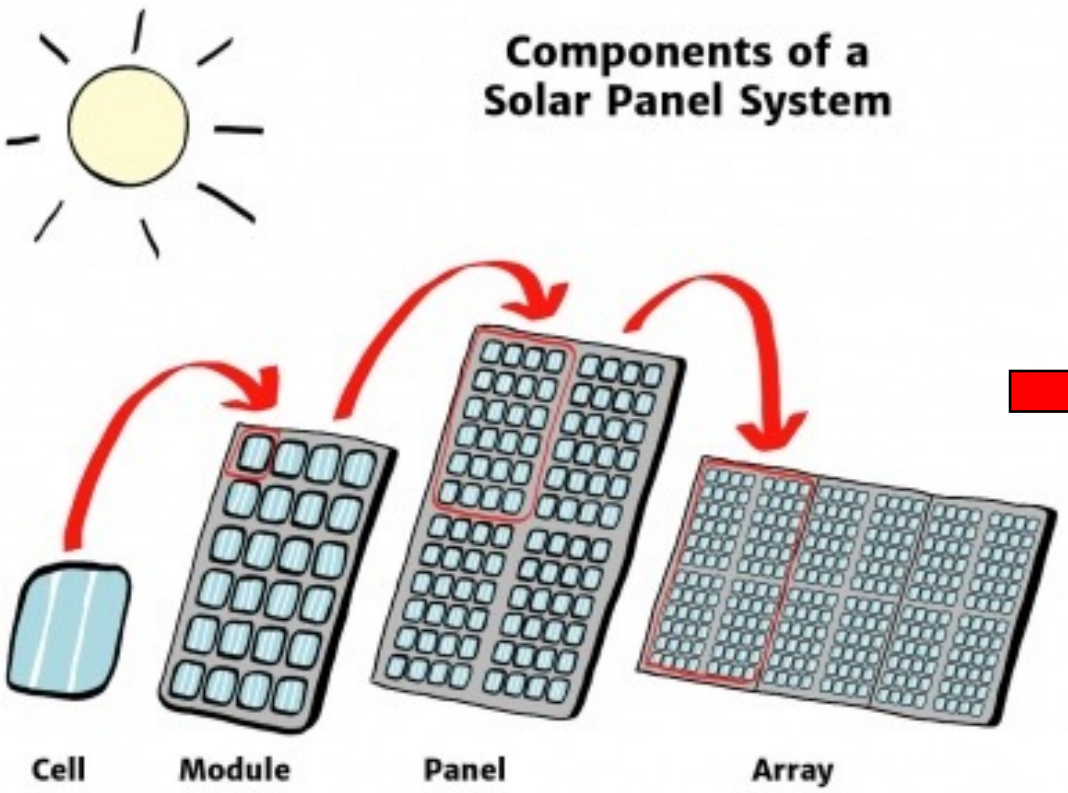
Session 1

Introduction

- What is a solar cell?

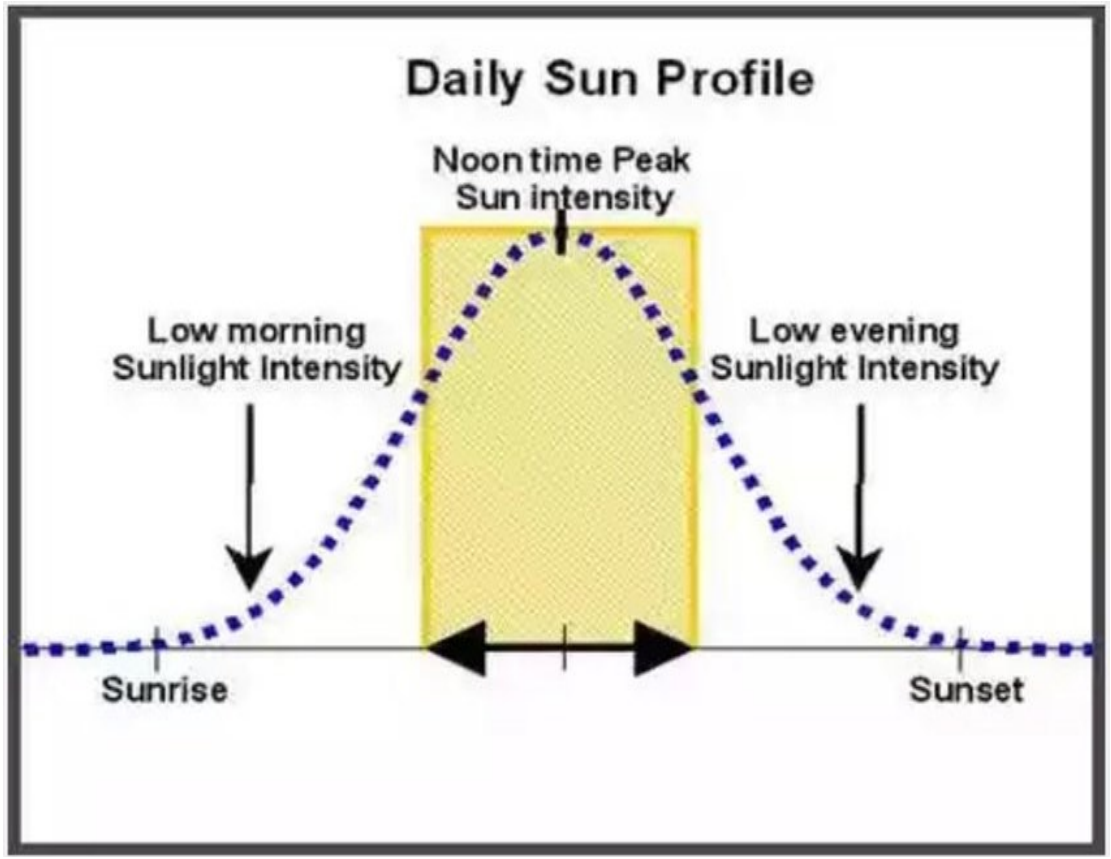
It is an electronic device that converts the sunlight into electricity by the photovoltaic effect.

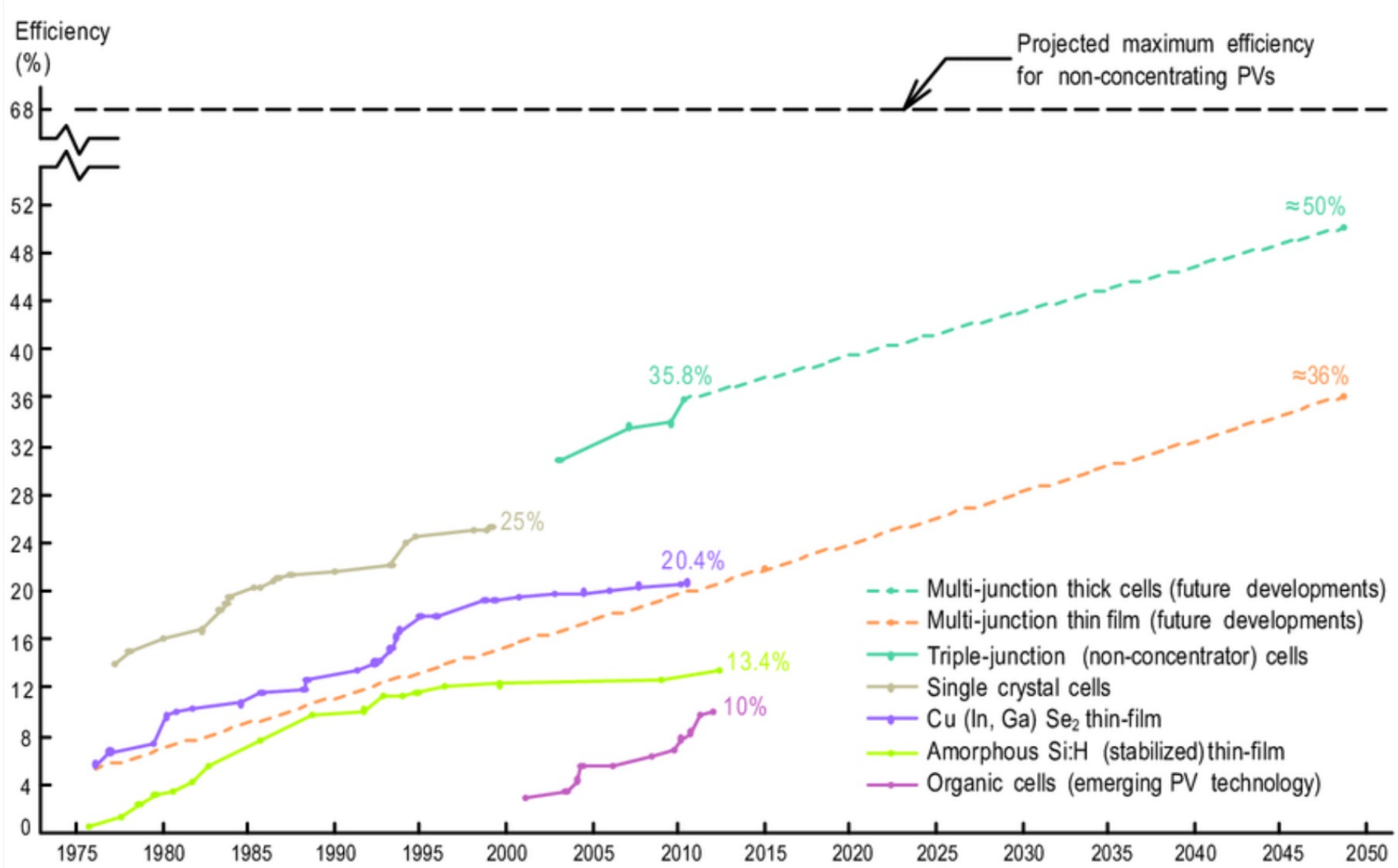
What is solar farm?



Solar farm

Effect of Intensity on power produced by solar cells

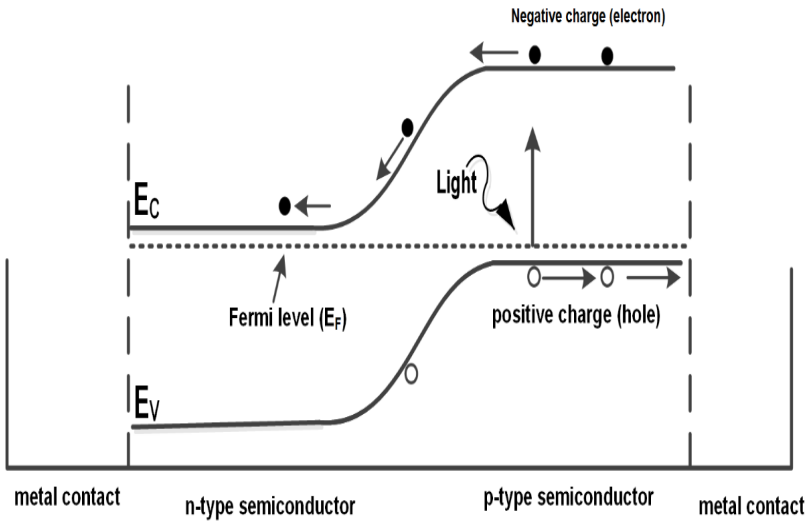




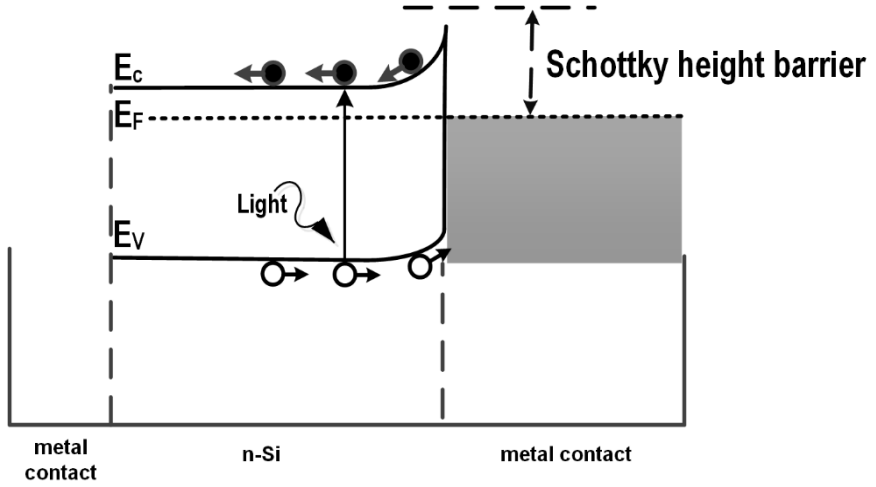
Historical trends in PV efficiency, with projections to 2050 ...

- How many ways can be solar cells prepared?

1. P-N junction solar cells.
2. Schottky junction solar cells.

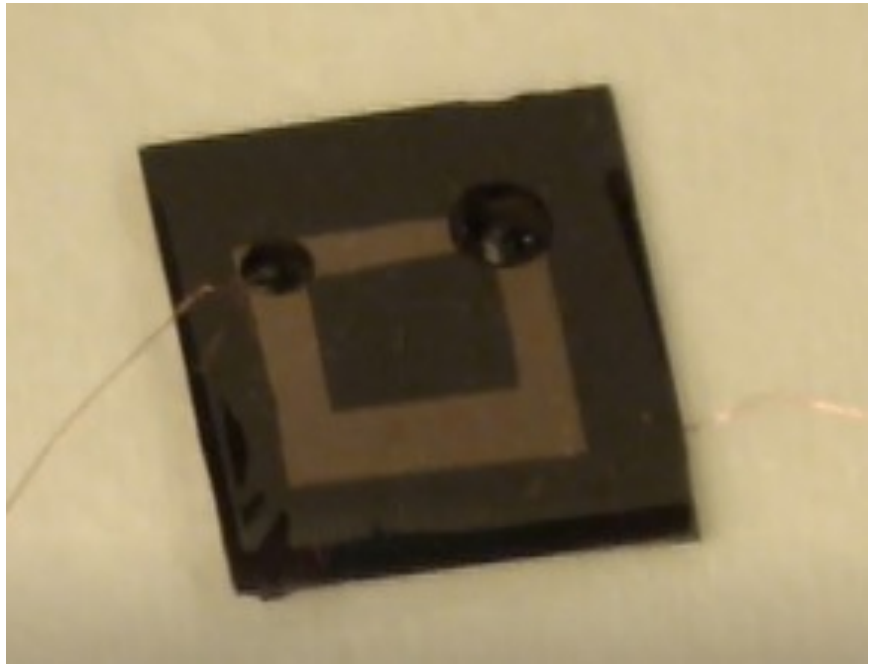


p-n junction solar cell.

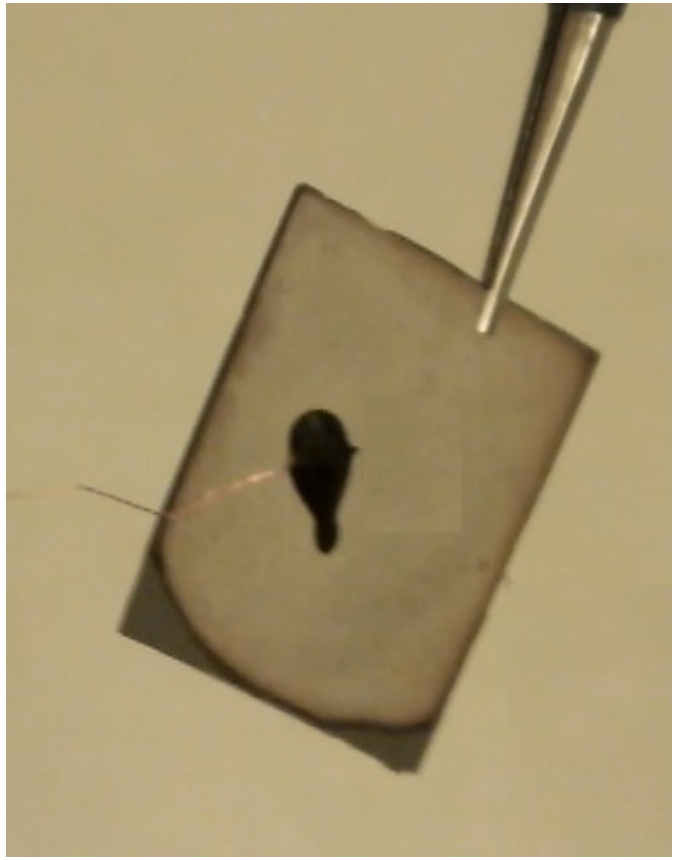


Schottky junction solar cell.

What we are going to fabricate in the summer training?



Front side of a graphene/n-Si Schottky junction Solar cell



Back side of a graphene/n-Si Schottky junction Solar cell

Which steps do we need to fabricate graphene/Si solar cells?

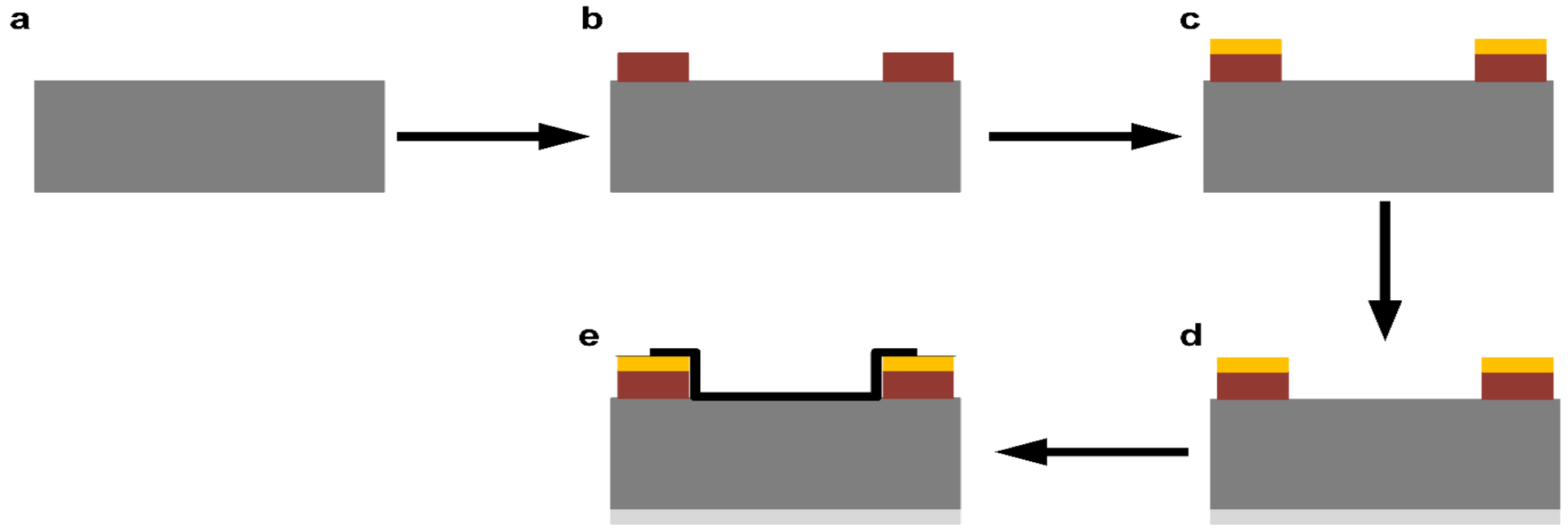


Figure. Fabrication process of a graphene/n-Si Schottky junction constructed via a top-window structure. (a) Cleaning process of Si wafers. (b), (c) and (d) forming contacts through lithography and sputtering processes. (e) Transferring CVD- graphene.

(Cleaning process)

Outlines

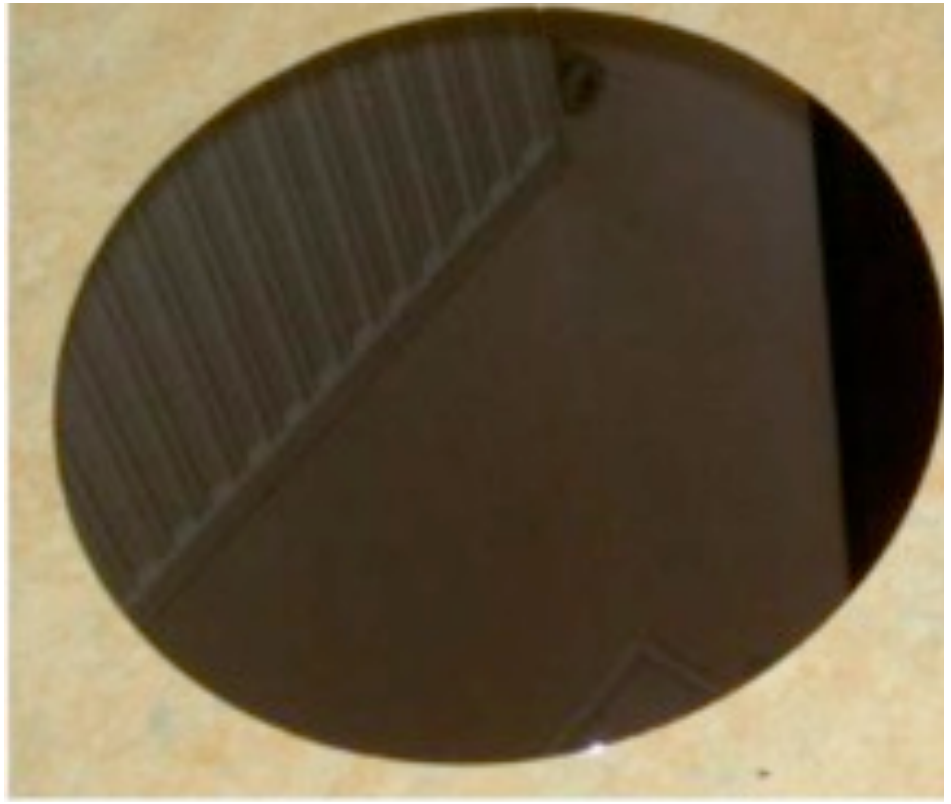
1.Introduction

2.Methodology

Methodology

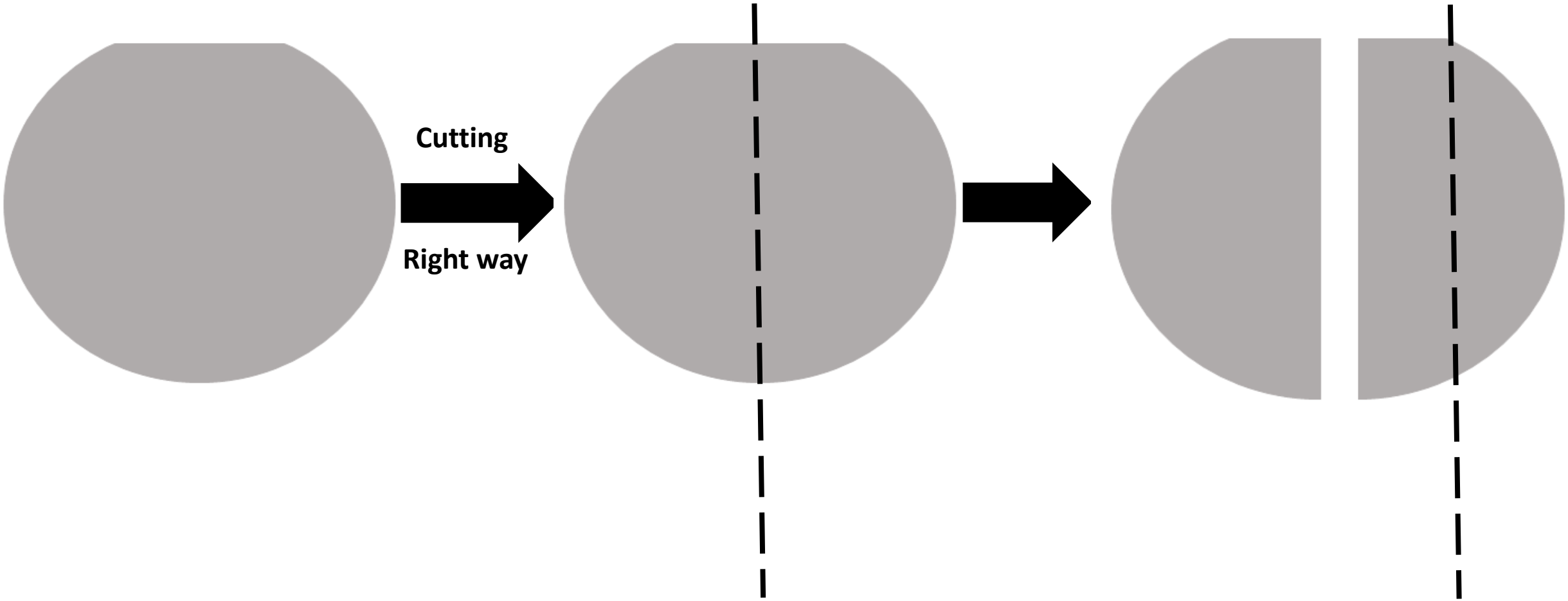
Materials:

1) N type-silicon wafers.
2) Cutter.
3) Ruler.
4) Acetone.
5) Isopropanol.
6) DI-water.
7) Potassium Hydroxide Oxide (KOH).
8) Clean room tissue.
9) N_2 gas.



Si wafer

How can we cut Si wafers?



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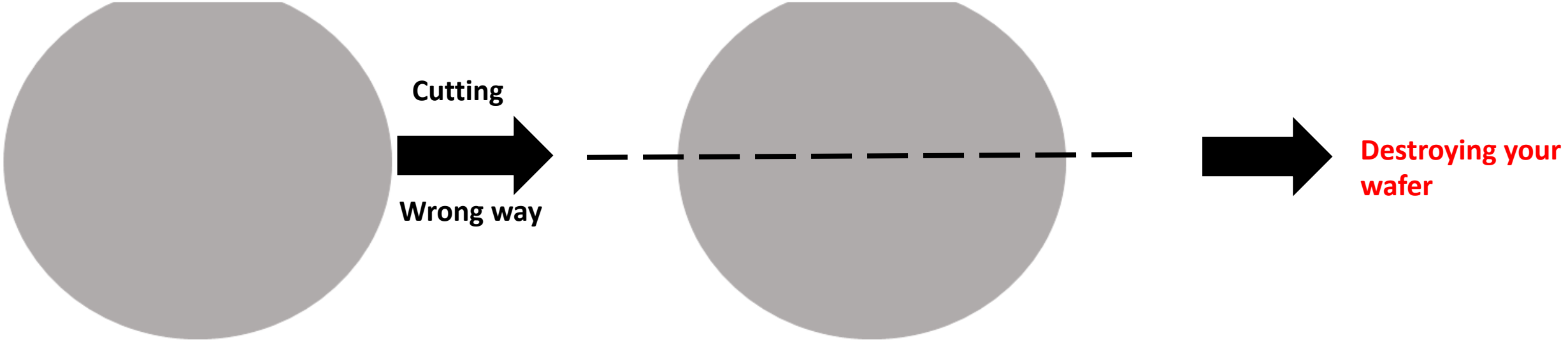


How can we clean Si wafers?

After cutting Si wafer into **1 Cm^2 areas**, cleaning process will start as follow:

Removing organic/inorganic residue:

I. Immersing Si sample in Acetone for 8 minutes.

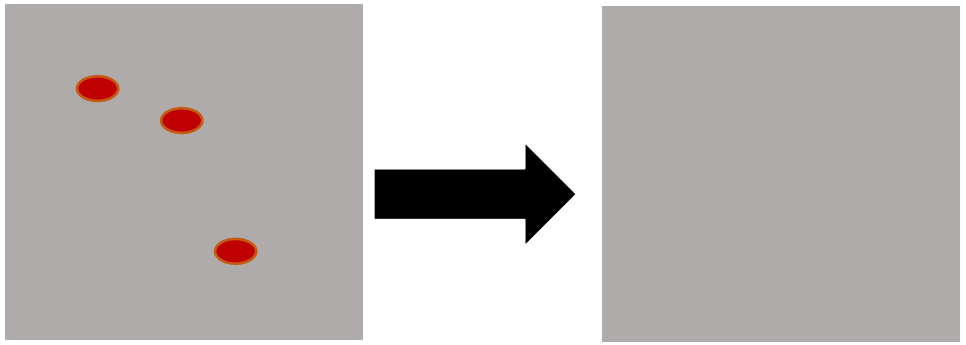
II. Immersing Si sample in Isopropanol (IPA) for 6 minutes.

III. Immersing Si sample in DI-water for 2 minutes.

Removing native oxide:

I. Immersing Si sample in 40% KOH for 1 minute.

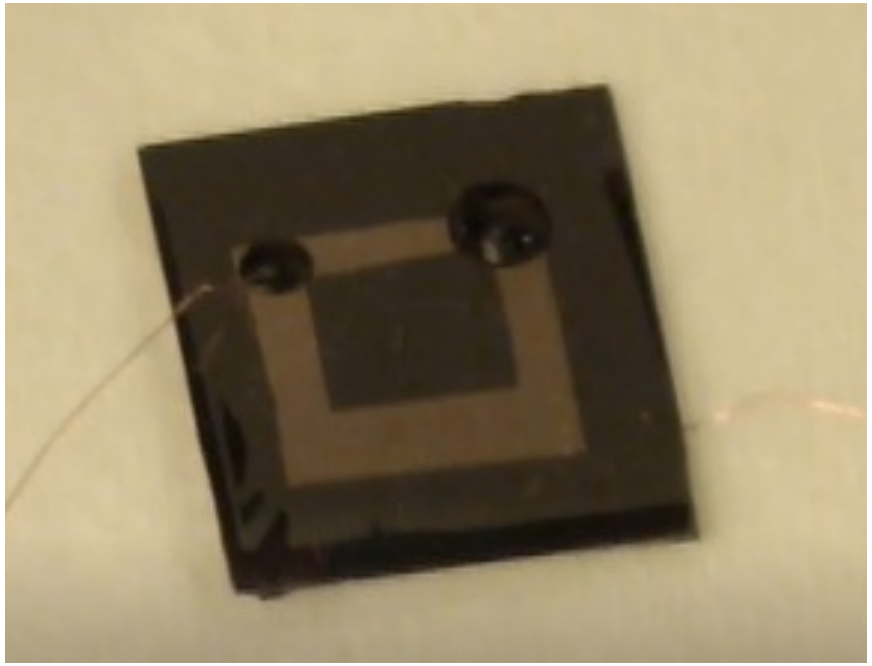
II. Immersing Si sample in DI-water for 2 minutes.



Before Cleaning **After Cleaning**

What is the next step of fabrication process?

Creating a square of metal on the front of Si samples through lithography and sputtering processes



(Photolithography process)

Dr. Ahmed Suhail

Outlines

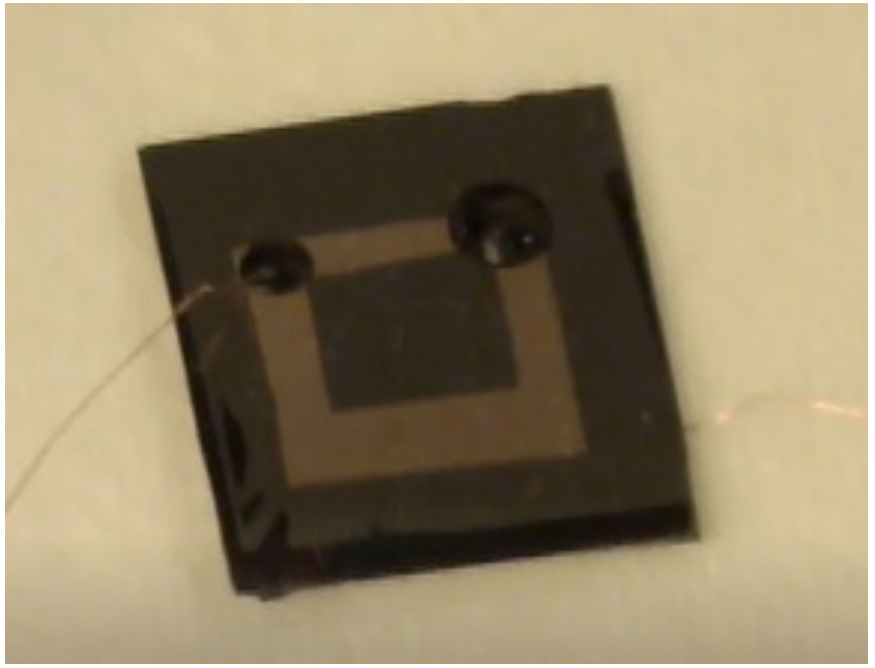
1.Introduction

2.Methodology

Introduction

What is Photolithography? What is the important of it?

It is a process to create a pattern onto a specific area of substrates. By using this process, you can pattern micro parts (or larger parts) of metals, semiconductors and insulators, which will be coated after. So, This process is crucial in the electronic industry.



Front side of device, showing a pattern of Au onto Si substrate.

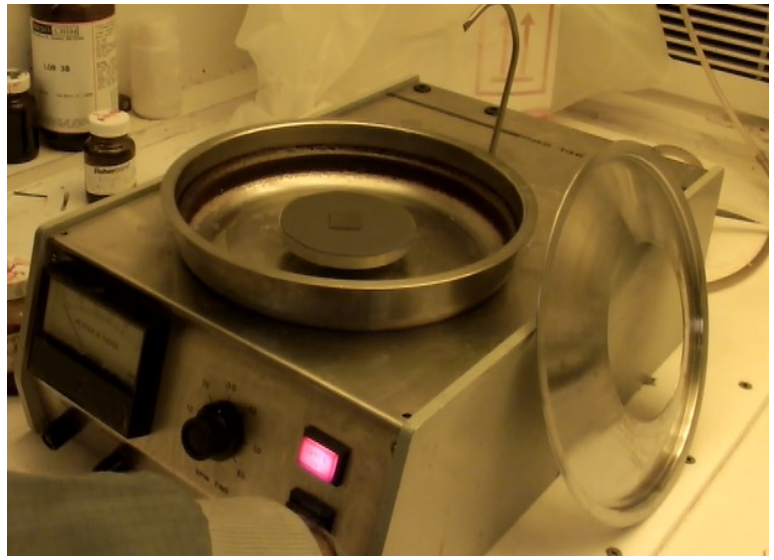
Methodology:

Materials:

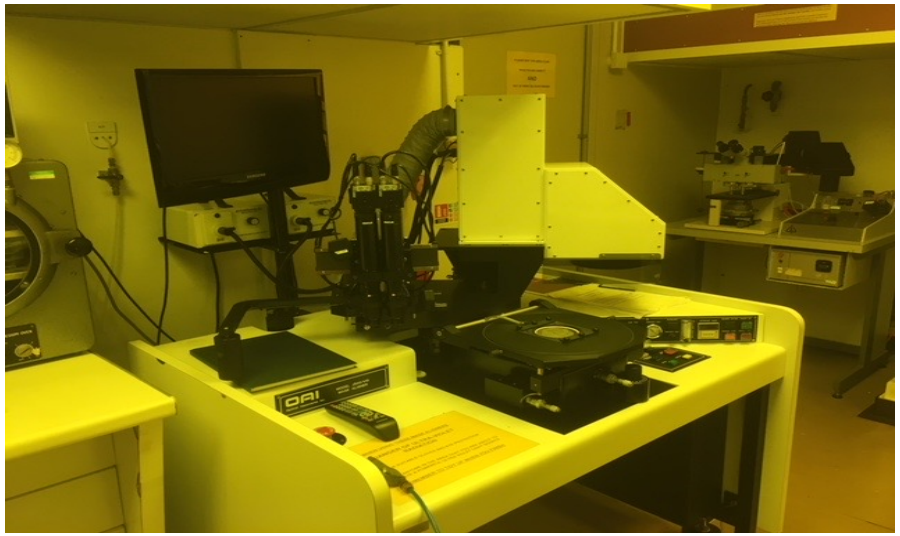
1) Positive-photoresist.
2) Pipettes.
3) Hot plat.
4) Spin coater (machine).
5) Mask.
6) Mask aligner (machine).
7) Developer.
8) DI-water.
9) Clean room tissue.
10) N_2 gas.

Photoresist

Pipette



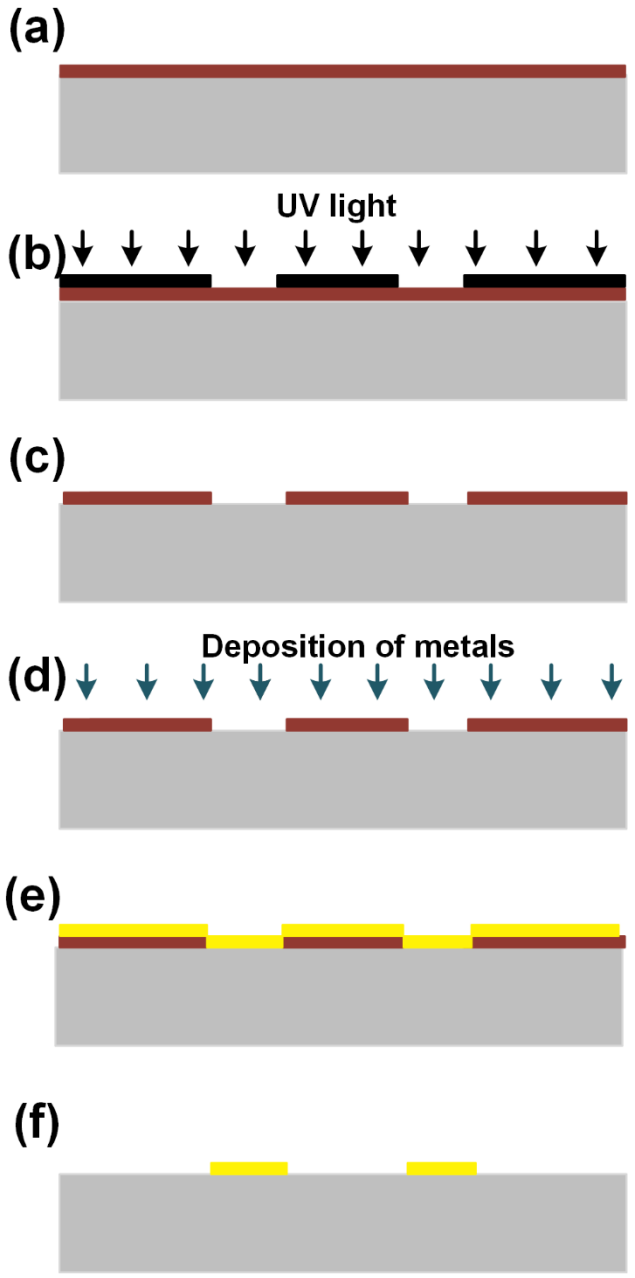
Spin-coater



Mask aligner

Photolithography process:

a-Coating with photoresist
b- Mask+ Exposing to UV
c- Developing
d and e- Coating procedure
f- Lift off process



Session 2

(Sputtering process)

Dr. Ahmed Suhail

Outlines

1.Introduction

2.Methodology

Introduction

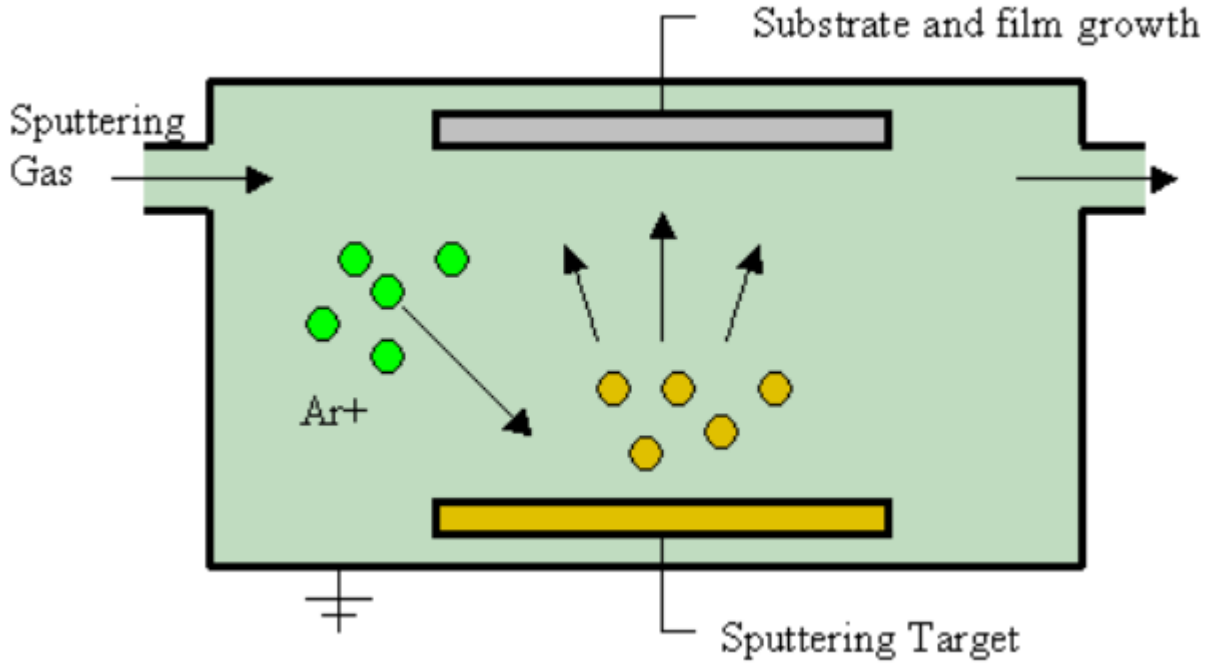
What is sputtering technique? What is the important of it?

A sputtering technique is used to deposit the required materials (metals, semiconductors and insulators) on desired substrates. It is important to achieve low-cost coating.

Three targets 8’’ sputtering machine

What is the key in sputtering process?

The key is the discharging of a carrier gas (such as, Argon).

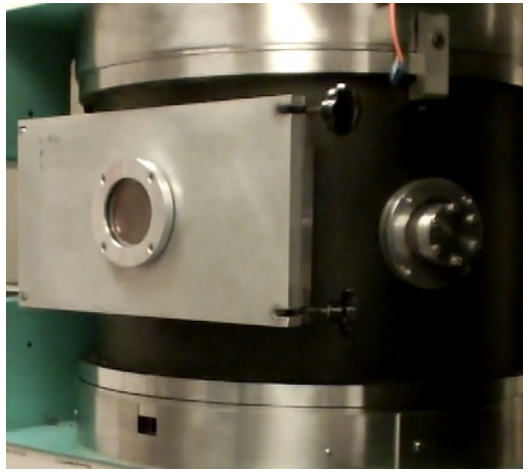


Sputtering machine includes:

1- Chamber

2- Mechanical pump

3- Diffusion pump



Chamber

Mech. Pump

Diffusion Pump

Methodology:

Materials and system:

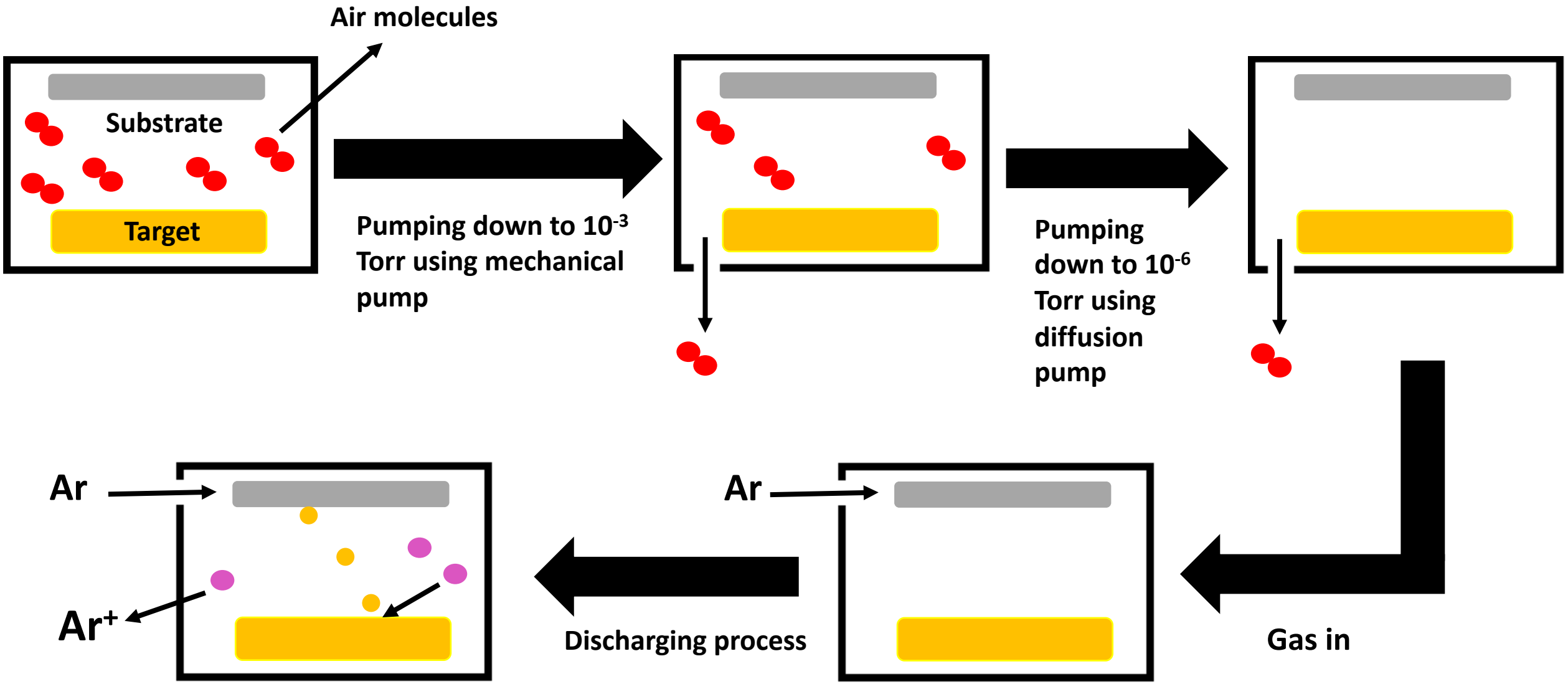
1) Water
2) N_2
3) Argon (Ar)
4) Compressed air
5) Sputtering machine
6) SiO_2, Au, Ag and Cr targets.

1,2,3 and 4

5

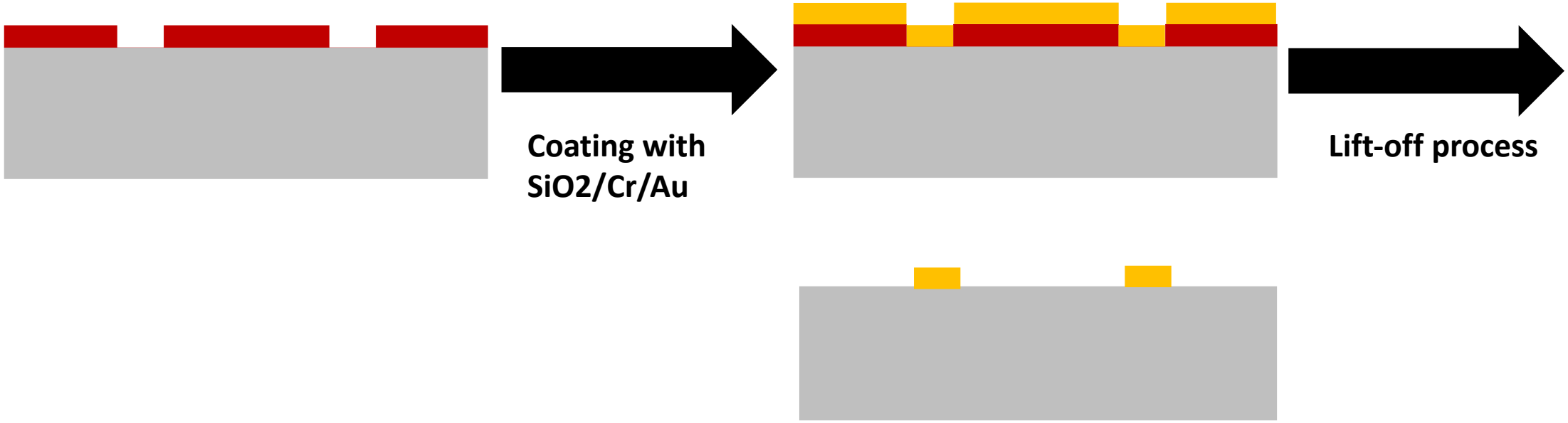
6

Sputtering process



What are the next steps of fabrication process?

After coating samples, lift-off process will be applied.



(Wet transfer process of CVD-graphene)

Outlines

1.Introduction

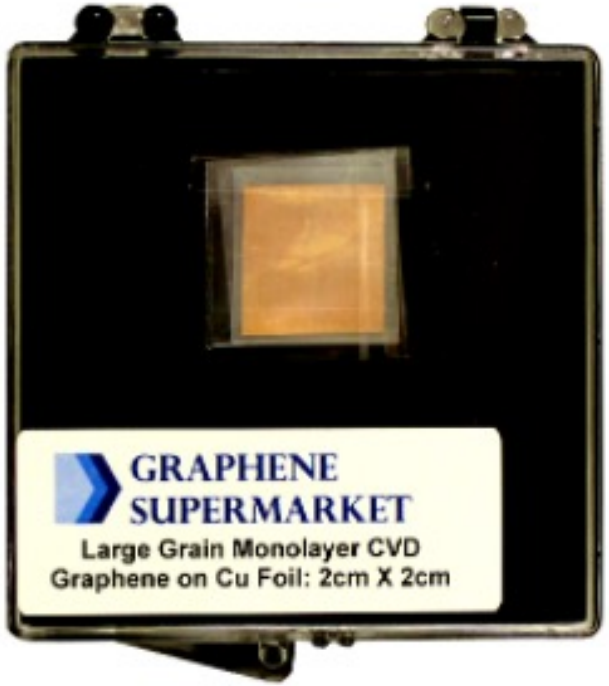
2.Methodology

Introduction

Chemical Vapour Deposition (CVD)- graphene

Chemical vapour deposition is the best way to obtain

high quality and large area of graphene.



CVD-graphene on copper foil

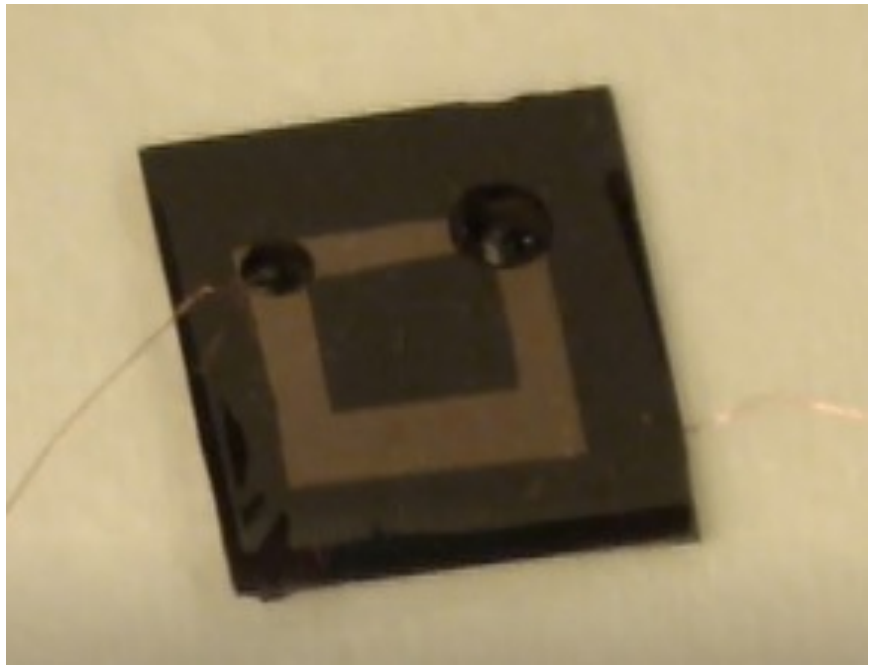
How is CVD-graphene formed on Cu in the fabrication process used?

The wet transfer process is used to transfer graphene from Cu into desired substrates.

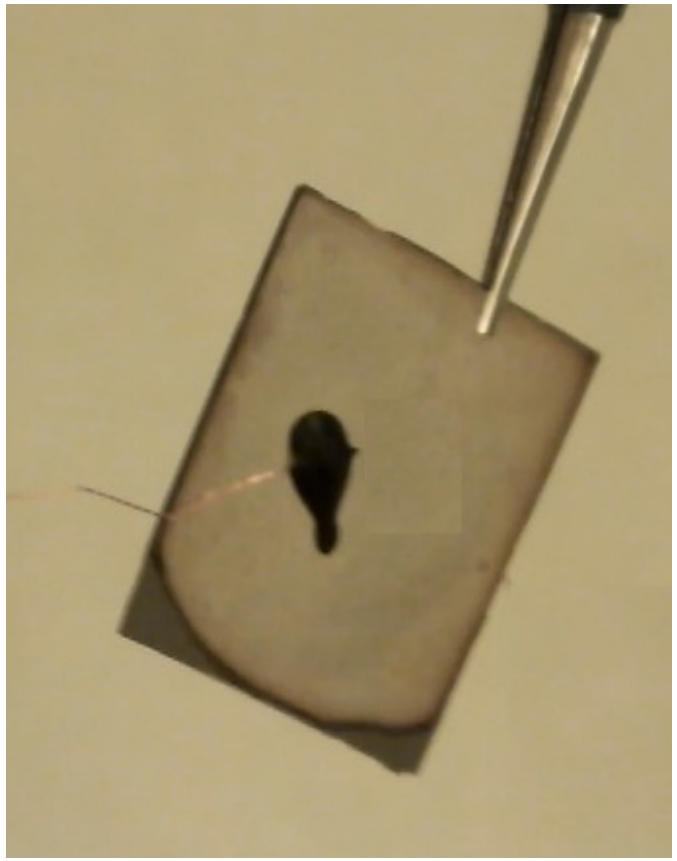
Methodology:

Materials and system:

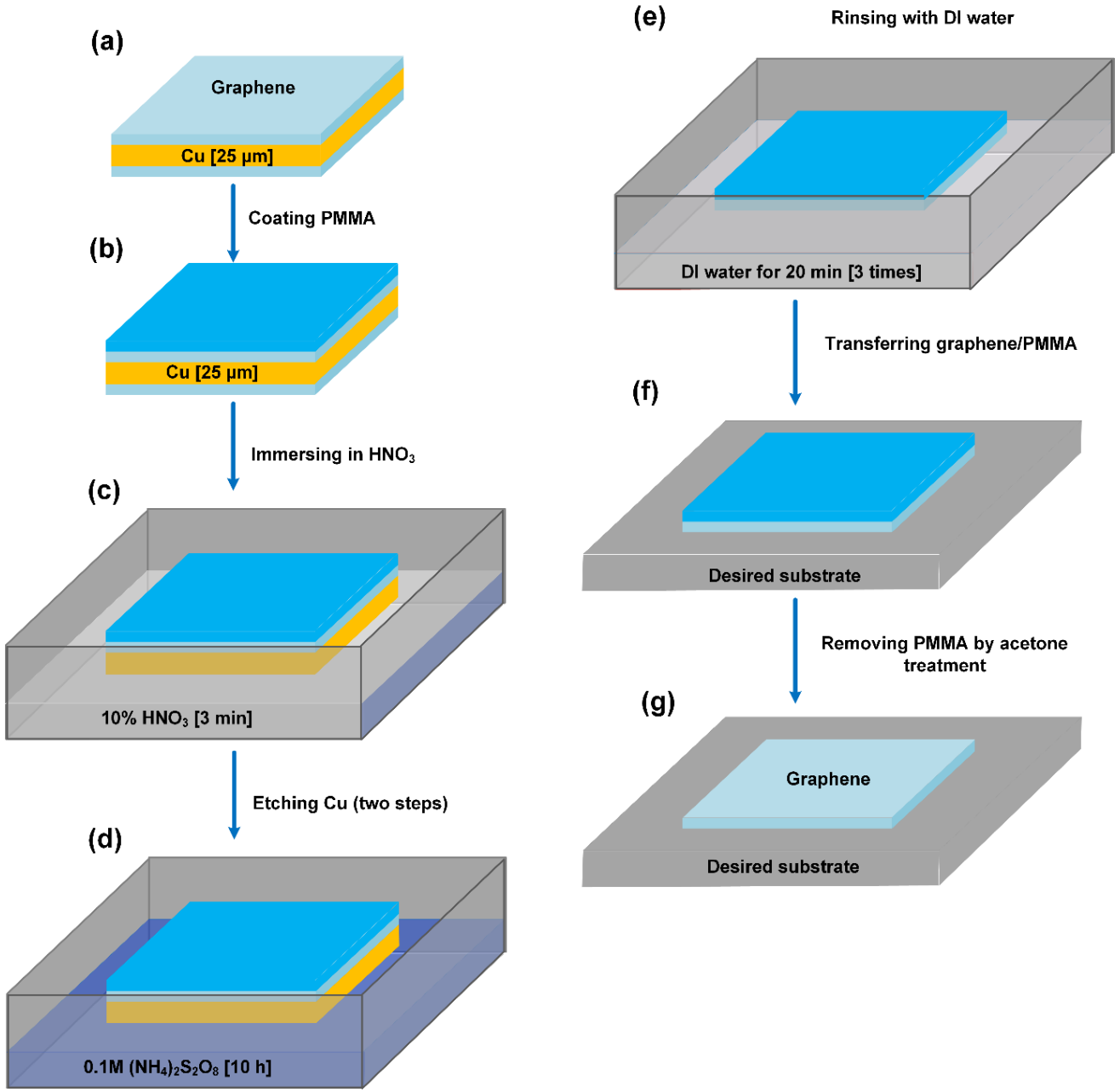
1) Spin coater
2) PMMA solution
3) Pipettes.
4) Hot plate
5) Nitric acid solution
6) Water
7) Ammonium persulfate solution
8) Acetone
9) IPA



Front side of a graphene/n-Si Schottky junction Solar cell



Back side of a graphene/n-Si Schottky junction Solar cell



Wet transfer process

Which steps do we need to fabricate graphene/Si solar cells?

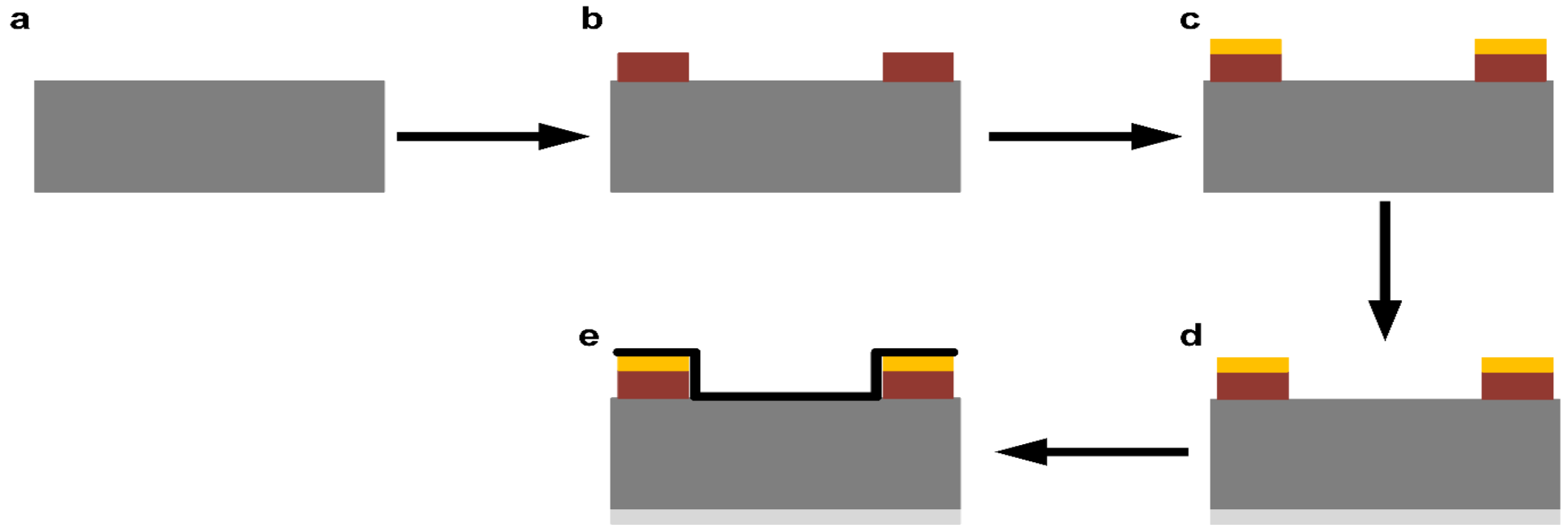


Figure. Fabrication process of a graphene/n-Si Schottky junction constructed via a top-window structure. (a) Cleaning process of Si wafers. (b), (c) and (d) forming contacts through lithography and sputtering processes. (e) Transferring CVD- graphene.

Conclusions:

1- Introduced 2 sessions on the manufacturing of graphene/Si Schottky junction solar cells.

2- Support Sustainable Development Goals (SDG) such as Quality Education (SDG 4) and Affordable and Clean Energy (SDG 7).