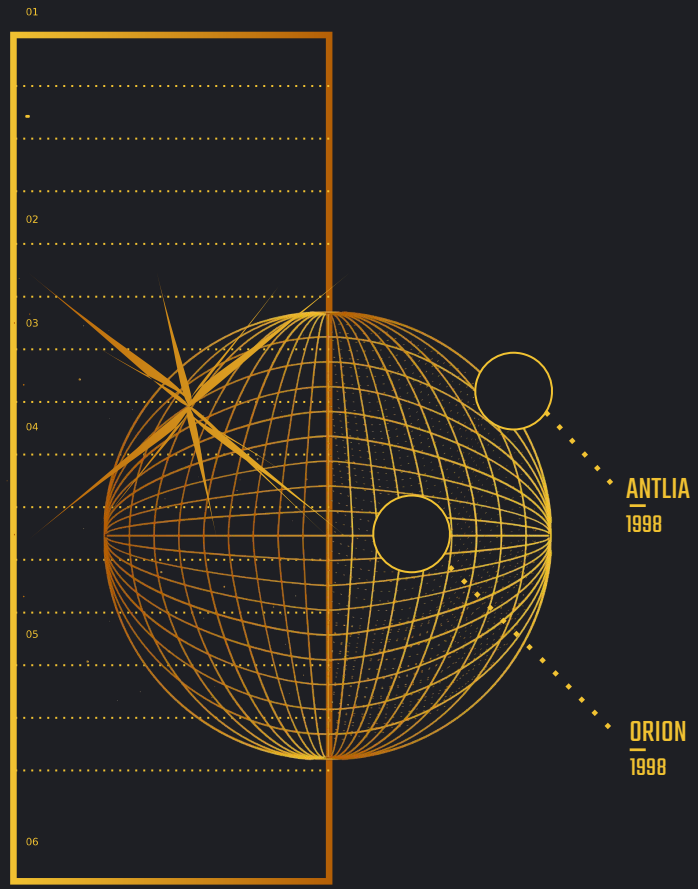
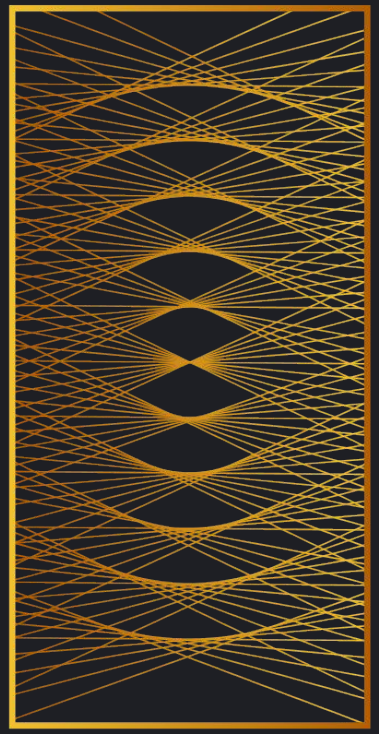
Optical and X-ray Lithography

Reading Project





01.

What is Lithography?

The act of printing, but expensive due to the high cost of the materials (gold sheets blocking the electrons to create X-rays)

Originated from Greek words

Lithos: stone

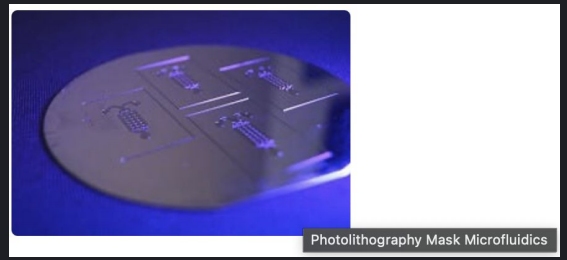
Graphein: to write

Together, they are mentioning the act of printing especially in microfabrication nowadays.

There are three types of mask: quartz, soda lime, and plastic mask. (result in different precision in resolution)

Using the mask with certain patterns to create pattern on the semiconductor (silicon materials/wafer) to alter the properties of the material (both physical and chemical).

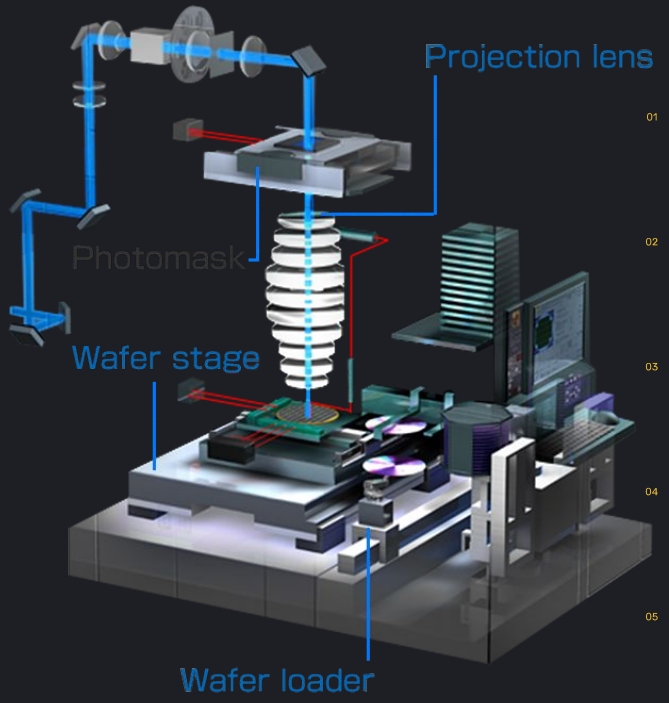
Today: Optical and X-ray Lithography

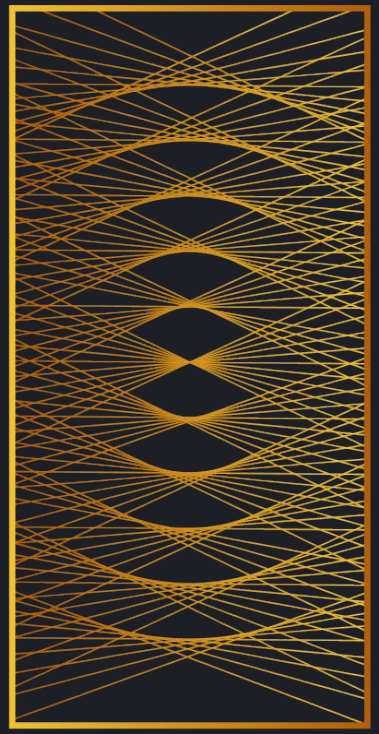


Why is lithography important?

Lithography can help building complex circuitry at high precision with small sizes. The features and performance of the electrical devices can be highly flexible and fast.

One could see that it is impossible to build a complex circuitry at small scale without lithography techniques.



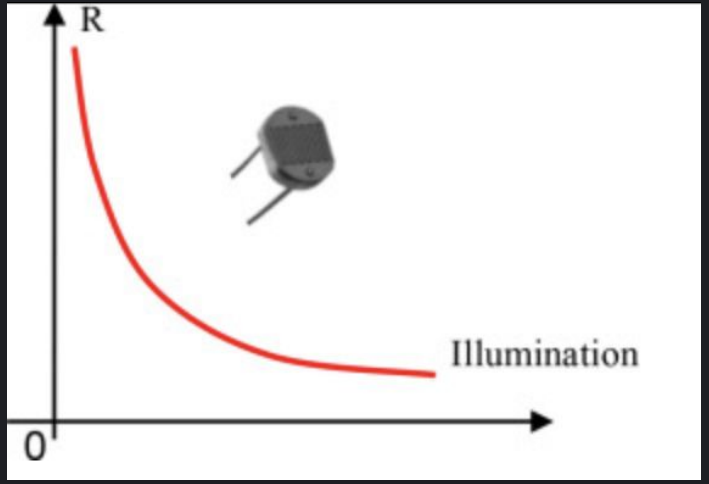


02.
What is Optical Lithography?

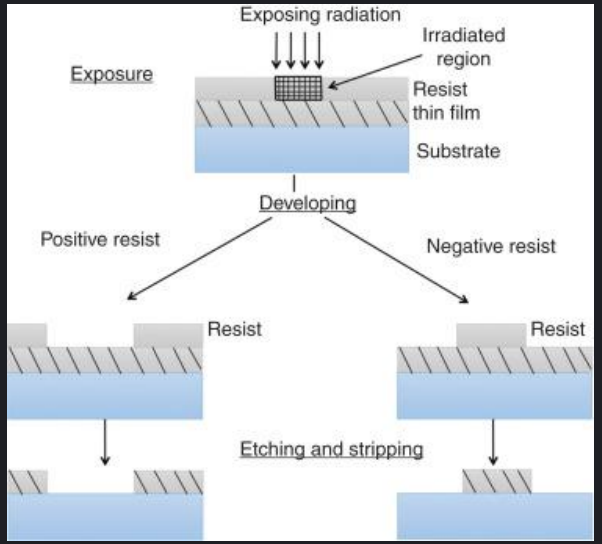
WHAT IS A PHOTORESIST?

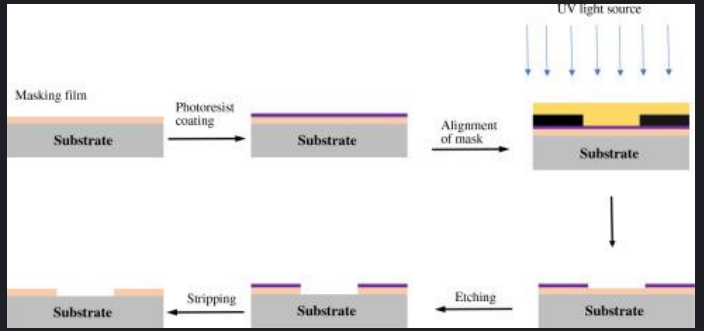
T1

A sensor that changes its resistance when light starts shining on it. The resistance decreases as lighting increases. Thus, we can manipulate its properties to print the desire pattern



The Mechanics of Optical Lithography





Quick Info

The field has been widely used and explored in the industry for many years such that there are many advantages and disadvantages already known

Limitation of Optical Lithography

The resolution depends fundamentally on the wavelength of the light using Reyleigh’s equation. (theta = 1.22 lambda/D)

The most advanced lithography gives around 193 nm at its best resolution onto the substrate.

For a better resolution, we need to work with X-ray Lithography.

Why X-ray Lithography?

Since the resolution of optical lithography has its limit, the alternative way is to use X-ray lithography.

However, this technique is more complex and expensive than optical lithography.

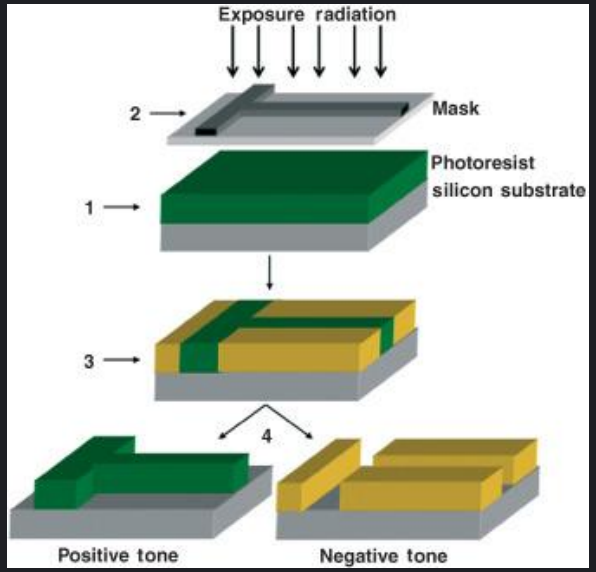
Nevertheless, this is necessary to be implemented in many cases.

The Mechanics of X-ray Lithography

Typically, the range of optical lithography ranges between 400 and 800 nm

However, X-ray has very small wavelengths (below 1nm) such that it overcomes the diffraction limit that we encountered.

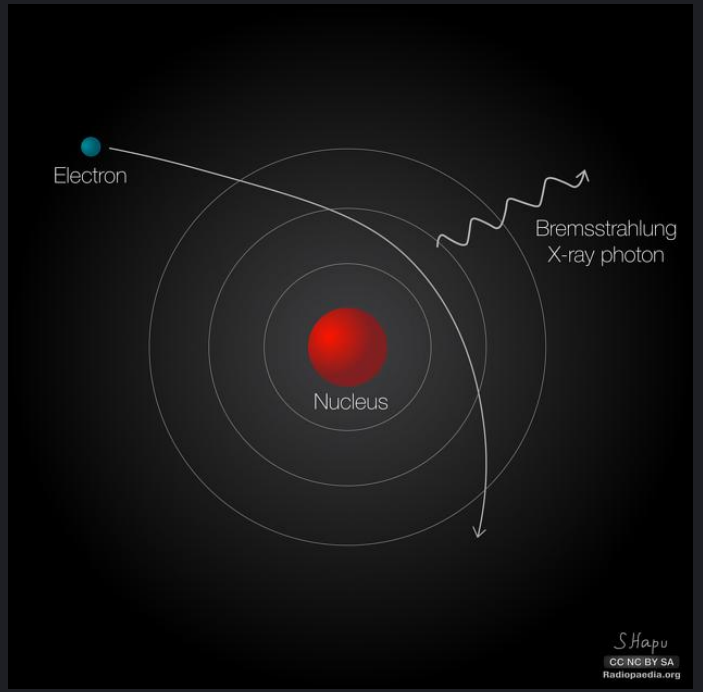
The process is essentially the same, but the incoming wavelength is significantly smaller. Because of that, specific materials are required to generate X-ray



Bremsstrahlung Radiation

One way to create X-ray is to shoot electrons through heavier nucleus such as the direction of electron alters and then emits radiation (X-ray) to converse momentum.

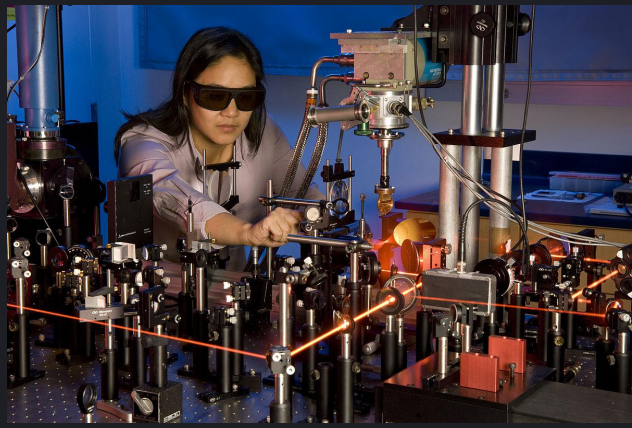
In practice, we have electrons colliding with metal foil (gold) after being accelerated by the potential difference from emf.

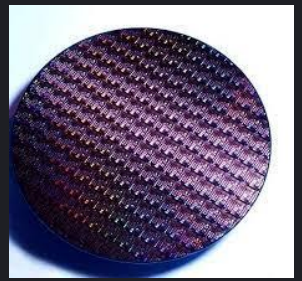


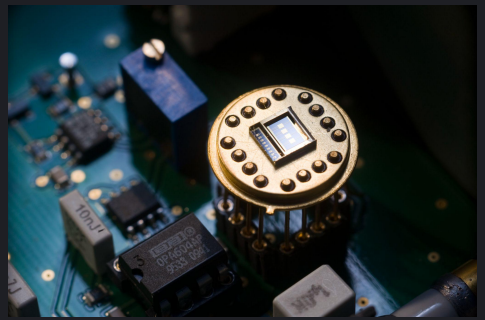
Applications

Optical Lithography: integrated circuit, Micro-electromechanical systems, Optoelectronics, …

X-ray Lithography: MEMS devices with high precisions, photonic devices,...



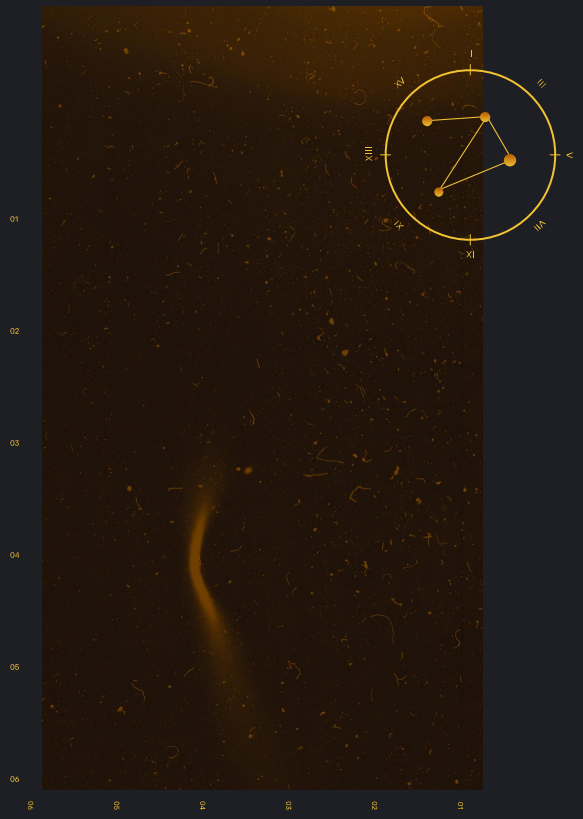




Summary

In short, one can categorize both optical and x-ray lithography into one area. However, the differences are crucial to be noted.

The field is already well developed and explored. But, there are still many ongoing research for greater complexity.



Sources

Photoresist: Design, Analysis, and Applications of Renewable Energy Systems, 2021

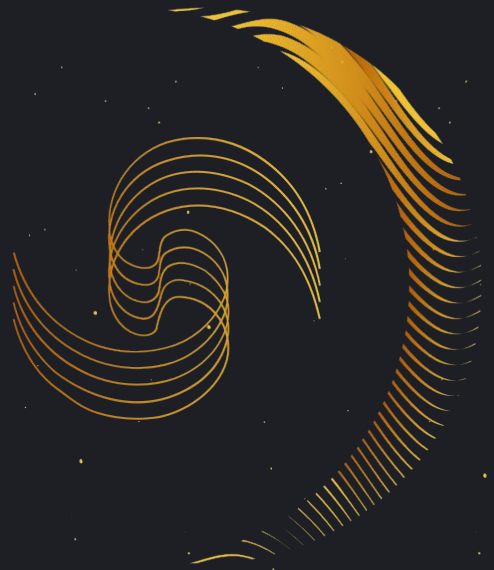
Mask:https://www.elveflow.com/microfluidic-reviews/soft-lithography-microfabrication/introduction-about-photomask-in-microfluidic/

Picture: By Fred the Oyster, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=35220299

THANKS

T

O



01 02 03 04 05 06

01 02 03 04 05 06