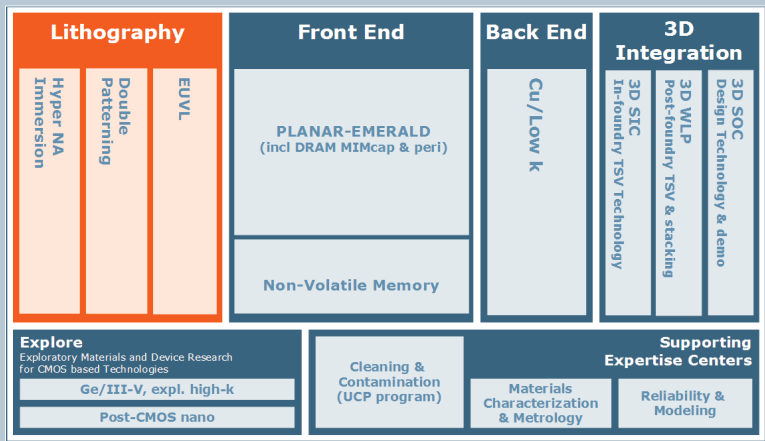


# Advanced lithography

## Positioning

This IIAP is part of IMEC's R&D platform towards sub-32nm CMOS:



## Scope

The Advanced Lithography program is focusing on (sub-)32nm half-pitch lithography options.

It is clear that 32nm half pitches will be extremely difficult to resolve using 193nm immersion lithography, at least if single exposures are targeted. Although it is theoretically possible, it will require high-index fluids instead of water as immersion liquid, but also an optical material for the last lens element with a higher index and additionally a very-high-index photoresist. Especially the development and the ROI model for the high-index optical material are considered a potential roadblock today. Also the manufacturability of hyper-NA ( $NA > 1$ ) imaging, limits of chemically amplified resists and defectivity requirements will remain challenging.

When considering double patterning using (water) immersion lithography, 32nm half pitches become feasible, but it remains questionable whether this is a cost effective solution for some applications. Since no fundamental new infrastructure needs to get in place, double patterning could be the only option that is timely available for patterning the 32nm half-pitch node.

On the other hand, EUV lithography is seen today as the prime candidate for printing the critical layers of 32nm half-pitch nodes. Moreover, EUV lithography also has extendibility to 22nm and even below. For EUV lithography the biggest risk will most likely be the timely readiness of the total infrastructure (resist, reticle technology...). The EUV projects that are proposed in this program are intended to accelerate the infrastructure development.



Regardless from the wavelength or technology chosen, the characteristics of the chemically amplified resists and their limitations will have a significant impact on the lithography performance.

This Advanced Lithography program therefore has four main objectives:

- Identify the key critical issues for EUV lithography and patterning and propose solutions to overcome them. As will be detailed in the work program below, the critical issues will be centered around EUV resists and processes, EUV reticle defectivity and EUV scanner performance.
- Establish a fundamental understanding of the challenges and issues with hyper-NA immersion lithography and to provide solutions to implement hyper-NA immersion for the 45nm and 32nm nodes.
- Explore the feasibility of double patterning as a potential (intermediate) solution for 32nm half-pitch nodes and find ways to make it more cost effective.
- Understand the fundamental characteristics and limitations of chemically amplified resist and study possible solutions.

Interaction with equipment suppliers, mask vendors, EDA and resist companies as well as the IC manufacturers, will be key to achieve the goals of this program.

## Structure & Activities

The Advanced Lithography program is currently subdivided into the following parts:

Sub-program 1: Immersion Lithography Extendibility

1. hyper-NA imaging including optical proximity correction (OPC);
2. alternative mask stacks;
3. high-index liquids and resists;
4. immersion resist process;
5. XT: I700Fi assessment.

Sub-program 2: Double Patterning

1. alternative process schemes;
2. design split and OPC;
3. double patterning based device integration;
4. double patterning manufacturability.

Sub-program 3: EUV lithography

1. EUV resists and processes feasibility;
2. EUV reticle defect printability and handling;
3. EUV alpha demo tool assessment.

Sub-program 4: Resist Fundamentals

## Partners

1. IC manufacturers, foundries...;
2. equipment and material suppliers (incl. mask shops, resist suppliers);
3. CAE software houses.



### **IMEC**

Katrien.Marent@imec.be  
Ph. +32 16 28 18 80  
F. +32 16 28 16 37

### **IMEC, Inc. - US**

Raffaella.Borzi@imec.be  
Ph. +1 408 551-4502  
F. +1 408 551-4505

### **IMEC Shanghai - P.R. China**

Gao.Teng@imec.be  
Ph. +86 21 6236-0700 ext. 18  
F. +86 21 6236-0706

### **IMEC Repr. Japan**

Akihiko.Ishitani@imec.be  
Ph. +81 35210 5882  
F. +81 3 5210 5883  
Mitsugu.Yoneyama@imec.be  
Ph. +81 80 5180 1081  
F. +81 3 5210 5883

### **IMEC Taiwan**

Tien-Fu.Lei@imec-tw.tw  
Ph. +886-3-5781115

### **IMEC Stichting Nederland**

Karin.Steenbergen@imec-nl.nl  
Ph. +31 40 277 4000