

Decoders 1.7: Introduction to Microfabrication

Style: *Individual*; Personal

To pass, you must: (i) attend all the cleanroom sessions, (ii) complete the sections of edX course and all the quizzes as outlined in the syllabus (progress will be checked and noted every week.), and (iii) define all microfabrication terms given in the classroom. By the end of Class #1, students must decide whether to register or drop the course.

Overview: In *Decoders 1.7*, cleanroom processes and fabrication techniques are aimed to be learned through lectures in class and then in cleanroom. At the end of each class, microfabrication terms are given to students to be defined. In the next class, students work together to explain these terms with associated sketches and analogies. The information is then collected in the class booklet. Students will gain hands-on experience with all six components of the microfabrication techniques including cleaning, deposition, patterning, etching, transfer printing and testing. The midterm project is to create a video of a microfabrication process (in groups of two or three) taught in the cleanroom and posted on the course website and YouTube channel. The final project is to identify a problem that can be tackled with a collective device fabricated in the cleanroom, which is the focus of *D1.8*.

- For homework, register *Micro and Nanofabrication (MEMS) course* at <https://www.edx.org/course/micro-nanofabrication-mems-epflx-memsx-0>
- [Cleanroom](#) (YellowBox) open hours will be held on Tuesdays from 9am to 11am.

Objectives:

1. To learn various cleanroom processes in the classroom setting,
2. To re-define the microfabrication terms learned in the classroom,
3. To experience the microfabrication processes in the cleanroom,
4. To create video clips of these processes with a personal style.

Schedule:

Class 1: September 9th, 2021 (E15-466 & E15-443a) – Introduction to YellowBox

Class 2: September 16th, 2021 (E15-466)

- a. Overview and introduction to microfabrication, cleanrooms, and processes:
 - i. *Lecture:* Microfabrication principles, comparison of technologies, fabrication phases.
 - 1. Six components of microfabrication – cleaning, deposition, patterning, etching, transfer printing, testing.
 - 2. Silicon, Other elemental or compound semiconductor, metals, glasses, quartz, sapphire, ceramics, plastics/polymers.
 - ii. *Lab:* Gowning, PPE procedure in the cleanroom. Particle contamination, contamination measurement, cleanroom chemistry and concepts.
 - iii. Substrate fabrication: Si: Poly, single crystal dicing.
 - iv. Provide microfabrication terms to be defined.
 - v. ***HW: Take the “MEMS and cleanroom introduction” section of edX Course and complete all online quizzes.***
 - vi. ***HW: Take the “Lithography” section of edX Course and complete all online quizzes.***

Class 3: September 23rd, 2021 (E15-443a)

- b. Patterning
 - vii. HWs will be checked.
 - viii. Work collectively on microfabrication terms given in Class #1.
 - ix. *Lecture:* Lithography, photoresist.
 - x. Provide microfabrication terms to be defined.
 - xi. Work collectively on microfabrication terms given in Class #2.
 - Lab:* Process steps, +/- resist, coating, developing, removing, contact and proximity exposure, projection, alignment and marks, light sources.
 - xii. Provide microfabrication terms to be defined.
 - xiii. ***HW: Take the “Chemical vapor deposition (CVD)” section of edX Course and complete all online quizzes.***
 - xiv. ***HW: Take the “Physical vapor deposition (PVD)” section of edX Course and complete all online quizzes.***

Class 4: September 30th, 2021 (E15-466)

- c. Design parameters and considerations for devices
 - xv. HWs will be checked.
 - xvi. Work collectively on microfabrication terms given in Class #3.
 - xvii. *Lecture*: Device requirements, environmental impact, cost factor.
- d. Deposition
 - xviii. *Lecture*: Thermal oxidation, Physical Vapor deposition (sputtering and E-beam), Chemical vapor deposition (CVD and PECVD), Atomic layer deposition (ALD), Epitaxy (vapor and liquid).
 - xix. Provide microfabrication terms to be defined.
 - xx. ***HW: Take the "Dry etching" section of edX Course and complete all online quizzes.***
 - xxi. ***HW: Take the "Wet etching" section of edX Course and complete all online quizzes.***

Class 5: October 7th, 2021 (E15-466)

- e. Etching
 - xxii. HWs will be checked.
 - xxiii. Work collectively on microfabrication terms given in Class #4.
 - xxiv. *Lecture*: Wet etch, dry etch.
 - xxv. Provide microfabrication terms to be defined.

Class 6: October 14th, 2021 (E15-443a)

- f. Etching
 - xxvi. Work collectively on microfabrication terms given in Class #5.
 - xxvii. *Lab*: Practicing etching.
 - xxviii. Provide microfabrication terms to be defined.

Class 7: October 21st, 2021 (E15-466)

- g. Transfer printing
 - xxix. Work collectively on microfabrication terms given in Class #6.
 - xxx. *Lecture*: Surface energy, adhesion and release dynamics, delamination velocity and surface energy release rate.
 - xxxi. Provide microfabrication terms to be defined.

Class 8: October 28th, 2021 (E15-443a)

- h. Transfer printing
 - xxxii. Work collectively on microfabrication terms given in Class #7.
 - xxxiii. *Lab*: Students one by one practice transfer printing with automatic, transfer printing tool.
 - xxxiv. Provide microfabrication terms to be defined.
 - xxxv. ***HW: Take the "Inspection and metrology" section of edX Course and complete all online quizzes.***

Class 9: November 4th, 2021 (E15-466 & E15-443a)

- i. Packaging and testing
 - xxxvi. HW will be checked.
 - xxxvii. Work collectively on microfabrication terms given in Class #8.
 - xxxviii. *Lecture*: Surface characterization, ACF cabling, electrical characterization/measurements.
 - xxxix. *Lab*: Probe station, microscopy, laser vibrometer.
 - xl. Provide microfabrication terms to be defined.

Class 10: November 18th, 2021 (E15-466)

- j. Internal feedback for the videos
 - xli. *Lecture*: Wrap up.
 - xlii. Defining the problem that is going to be tackled in the next course.
 - xliii. Forming the booklet consists of defined microfabrication terms.
 - xliv. Suggestions for future class.

Class 11: December 2nd, 2021 (E15-466)

- k. *Lecture*: Final video presentation (internally, to the PI).

Class 12: December 9th, 2021 (E15-466)

- l. Video Editing & Publishing
- m. Project
 - xlv. Presentations and demo open to the Media Lab.
 - xlvi. Video contest at Media Lab.

Calendar

September 2021

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8 First Day of Classes	9 Class 1: Introduction	10	11
12	13	14	15	16 Class 2: Materials Science Background	17	18
19	20	21	22	23 Class 3: Patterning I	24	25
26	27	28	29	30 Class 4: Patterning II		

October 2021

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7 Class 5: Design I	8	9
10	11 Indigenous People's Day	12	13	14 Class 6: Design II	15	16
17	18	19	20	21 Class 7: Deposition	22	23
24	25	26	27	28 Class 8: Etching	29	30
31						

November 2021						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5
				Class 9: Packaging and Testing		
7	8	9	10	Veterans Day	12	13
14	15	16	17	Class 10: Internal Video Screening	19	20
21	22	23	24	Thanksgiving	26	27
28	29	30				

December 2021						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
				Class 11: Final Video Screening		
5	6	7	8	Class 12: Video Contest (Last Day of Classes)	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	