

EUPROMETA – 33rd Doctoral School on Metamaterials,
3-6 April 2017, University of Bordeaux, France

Metasurfaces
School Tentative Program



3 April – Monday

Hour	Topic	Lecturer
09:00 – 10:30	Participant registration - Welcome Coffee	
10:30 – 10:40	Opening and introductory information	
10:40 – 11:30	Basics of metamaterials – Part I - definition of metamaterials. - complex material responses in electromagnetics - anisotropy and bi-isotropy - chirality and magnetoelectric coupling - reciprocity and non-reciprocity - general bianisotropy: principal, skewon, axion parts of medium response	Prof. Ari Sihvola
11:30 – 12:20	Basics of metamaterials – Part II - radial anisotropy: systropic, bulbic, and porcupic metamaterials - basic dispersion models for material response - classical mixing and homogenization principles - electromagnetic boundary conditions from simple to complex - impedance boundaries, PEC, PMC, PEMS, SH, DB, SHDB, and GSHDB conditions	Prof. Ari Sihvola
12:30 – 13:50	Lunch	
14:00 – 14:50	Introduction to Metasurfaces – Part I 1. Prehistory of MS: 1.1 Microwave analogues: 1.1.1. Frequency-selective surfaces, 1.1.2. EBG structures, 1.1.3. Transmit-arrays and reflect-arrays 1.2 Holograms in optics	Prof. Constantin Simovski

	<ul style="list-style-type: none"> 2. From optically substantial to subwavelength patterning: <ul style="list-style-type: none"> 2.1 Electric current sheets 2.2 Magneto-dielectric current sheets 2.3 Bianisotropic MS 3. Perfectly absorbing MS <ul style="list-style-type: none"> 3.1 General operation principles 3.2 Optical models 4. Polarization transformers <ul style="list-style-type: none"> 4.1. Optical activity in thin sheets 4.2 Polarization sensitivity 5. Non-uniform MS <ul style="list-style-type: none"> 5.1 Generalized refraction law 5.1 General methods of wavefront manipulation 5.2 Tunable wavefront manipulation 6. Other types of MS (leaky-wave MS, metalenses, etc) 7. Concluding remarks 	
14:50 – 15:40	Introduction to Metasurfaces – Part II	Prof. Constantin Simovski
15:40 – 18:00	Coffee break and poster session Followed by wine and cheese	

4 April – Tuesday

Hour	Topic	Lecturer
09:00 – 9:50	Microwave Metasurfaces – Part I	Prof. Constantin Simovski
9:50 – 10:20	Coffee break	
10:20 – 11:10	Microwave Metasurfaces – Part II	Prof. Constantin Simovski
11:10 – 12:00	TeraHertz Metasurfaces – Part I	Prof. Willie Padilla
12:15 – 13:45	Lunch	
13:50 – 14:40	TeraHertz Metasurfaces – Part II	Prof. Willie Padilla
15:00 – 17:30	Social event Visit and wine tasting at “Chateau Larrivet Haut-Brion ”	
19:30 – 21:30	School dinner in Bordeaux city	

5 April – Wednesday

Hour	Topic	Lecturer
9:00 – 9:50	Nano-optics with Metasurfaces – Part I	Dr Philippe Lalanne
9:50 – 10:20	Coffee break	
10:20 – 11:10	Nano-optics with Metasurfaces – Part II	Dr Philippe Lalanne
11:10 – 12:00	<p>All Dielectric Metasurfaces – Part I</p> <p>This lecture will overview the state of the art of research into metasurfaces consisting of two-dimensional arrangements of high-refractive-index dielectric nanoresonators. It will start by providing the motivations for this research area and by putting it into context with research focussing on plasmonic metasurfaces. Next, fundamental concepts regarding the optical properties of subwavelength dielectric nanoresonators will be established. To this end, I will discuss Mie-resonances in dielectric nanoparticles and analyse how they are influenced by the nanoparticle shape, size, material composition, and coupling to other nanoparticles. I will then turn to homogeneous dielectric metasurfaces, before focussing on graded Mie-resonant dielectric metasurfaces for wavefront control applications in more detail. Following this, I will provide an overview of the recent progress in active, tunable and nonlinear dielectric and semiconductor metasurfaces. Finally, potential applications of dielectric metasurfaces and the respective challenges are discussed.</p> <p>Covered topics</p> <ul style="list-style-type: none"> ➤ Optical properties of high-index dielectric nanoparticles ➤ Fundamentals of resonant dielectric metasurfaces ➤ Electric and magnetic mirrors without metals ➤ Fano resonant dielectric metasurfaces ➤ Wavefront control with dielectric metasurfaces ➤ Active control of dielectric metasurfaces ➤ Nonlinear dielectric metasurfaces ➤ Light emission from dielectric metasurfaces ➤ Application prospects and challenges of dielectric metasurfaces 	Dr Isabelle Staude
12:15 – 13:45	Lunch	
14:00 – 14:50	All Dielectric Metasurfaces – Part II	Dr Isabelle Staude
14:50 – 15:40	Plasmonic Metasurfaces– Part I: Far-Field applications - Introduction	Dr Patrice Genevet

	<ul style="list-style-type: none"> - Modelling of plasmonic antennas - Birefringent interfaces - reflect-arrays - applications (phase plates, holograms and polarization plates) 	
15:40 – 16:00	Coffee Break	
16:00 – 16:50	Plasmonic Metasurfaces – Part II: Near-field applications <ul style="list-style-type: none"> - Surface holography - Cherenkov excitation of directional plasmons - Non diffracting plasmons - Conclusion and discussion on boundary conditions at arbitrary interfaces. 	Dr Patrice Genevet

6 April – Thursday

Hour	Topic	Lecturer
09:00 – 9:50	Free-form Surfaces In transformation optics, coordinate transformations are usually mapped onto equivalent (meta-)material parameter distributions. In 2015, we introduced an alternative approach mapping coordinate transformations onto dielectric free-form surfaces. We presented model experiments on cloaking of otherwise shadowing contact fingers on solar cells. More recently, we have fabricated masters by 3D laser lithography used for soft imprinting – opening the door to mass fabrication. For prototype silicon heterojunction solar cells investigated under 1-sun illumination, we find the predicted 9% relative efficiency increase. We additionally show that our approach is adaptable to Lambertian sources, thereby cloaking contacts on diffusively light-emitting diodes (e.g., on OLEDs) to achieve spatially homogeneous (white-light) emission.	Prof. Martin Wegener Karlsruhe Institute of Technology, Karlsruhe, Germany
9:50 – 10:20	Coffee break	
10:20 – 11:10	Examples of optical characterization of Metasurfaces	Dr. Alexandre Baron
11:10 – 12:00	Bottom-up fabrication of Metasurfaces	Dr. Virginie Ponsinet
12:00 – 13:30	Lunch and end of School	