

# Bio-Inspired Materials

## SCI-Arc Semester: Spring 2012

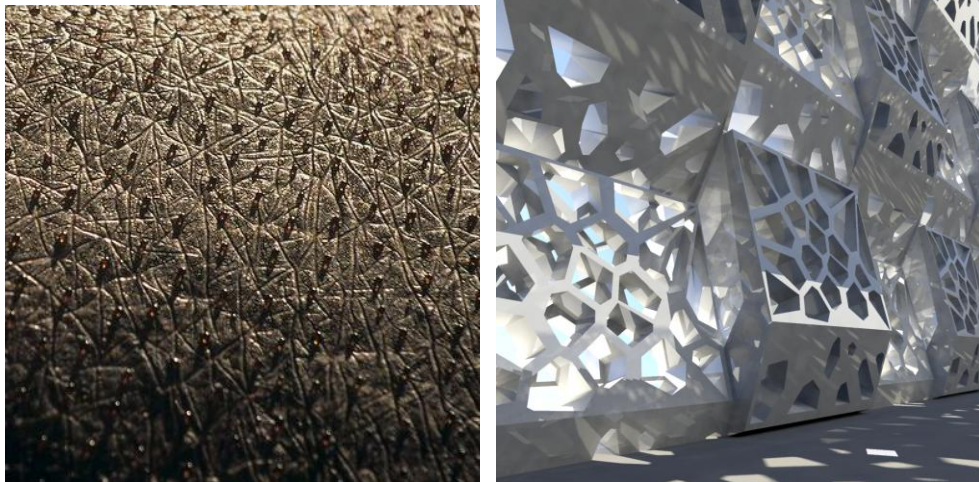
**Instructor:**

Ilaria Mazzoleni, Instructor - imsciarc@yahoo.com

**Course Meetings:**

Day: Thursdays

Time 1-4pm – Room 226



Hippopotamus Skin – Building Envelope (student project by S. Maansson & W. Raksaphon)

*Biomimetics has been the inspiration for new materials, because materials in living systems are remarkable strong, lightweight, and effective (Andrade, 2000). Proteins in spider silk are being copied for their strength. Composite materials that can serve several functions simultaneously were inspired by materials in living things. A synthetic material that seals tiny cracks that develop within it was inspired by the way wounds heal (Sparks, 2002)*

### Course Description

Beyond the traditional studies of materials and methods, architecture has moved towards an interdisciplinary approach to develop building technologies. Today, we design and engineer flexible and dynamic material systems to mediate the interaction between man and nature. Students of this course will examine nature in order to enhance our material design abilities and create a more intelligent way of living by interfacing with the environment in a more sophisticated and less invasive way.

The seminar undertakes an in-depth analysis of bio-inspired materials, starting from the understanding of what constitutes matter and materials. The emphasis is upon the research of bio-composites and bio-materials.

Through research and lectures the students will gain substantial knowledge and understanding of advanced material properties and characteristics which will be then applied in the second part of the course to the development of more focused research ideas related to possible architectural application to building envelopes. The analogy animal skin / building envelope has been the focus of precedent studies. During the course of this semester we will focus on to the materiality aspect of the making of architectural facade assemblies.

Skin is a complex and incredibly sophisticated organ that performs varied functions, including protection, sensation, and heat and water regulation. In a similar way building envelopes serve multiple roles, as they are the interface between the building inhabitants and the external environmental elements (e.g. water, air, sound, light and temperature). Building envelopes offer safety and privacy, insulation, and ventilation.

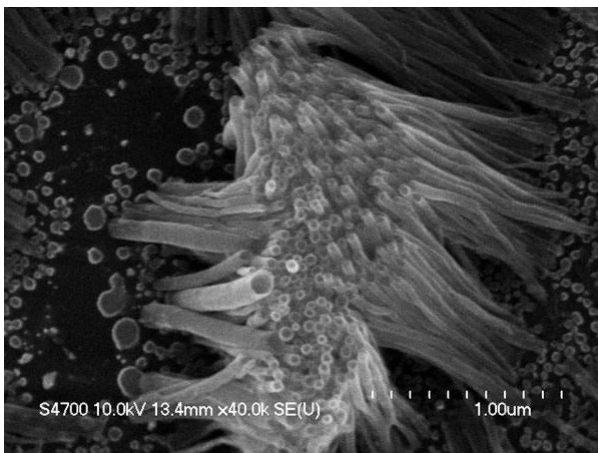
Evaluating first the needed characteristics, then the possible materials and assemblies under development in many different scientific fields that may constitute a breakthrough in the construction industry, will be the aim of the seminar research.

### Course Organization and Objectives

*"Since natural structures evolve over millions of years, they're often more intelligently designed than man-made ones for similar purposes. Architects and engineers are always looking for fresh approaches to solving structural problems. Nature has much to teach, not just about aesthetic forms but about mechanics." (Lorraine Lin)*

During the research and lecture portion of the class students will be exposed to the theoretical principles explained by material and aerospace scientists, building engineers and architects, through case studies and field trips, including Caltech and JPL. Invited guest lecturers include: Evolutionary Biologist Shauna Price, Zoologist Graham Slater, Architect and Biologist Sarah Dennison, Caltech Professor of Aeronautics and Applied Physics Chiara Daraio, Structural Engineer Lorraine Lin, JPL senior scientist Yoseph Bar-Cohen, among others.

Students will select a project topic and conduct concentrated research on a specific subject which will be developed and compiled in a class publication.



<http://www.phy.mtu.edu/images/research/Nanoscience.jpg>

## Project Overview

Following the one-week start up project based on individual research, students, working individually or in team of 2, will for the first weeks study and analyze a selected bio-inspired material. The initial understanding and written re-elaboration of the fundamental principles of bio-materiality will provide the basis for the investigation of possible applications to a building envelope that will be developed in the second part of the semester.

Start-up research: Individual

Project 1: individual or in team of two. Two components:

- part one: Bio-Inspired materials research
- part two: Building envelope application of research bio-inspired materials

Each student will present the project to the whole class for discussion.

Submittal requirements:

- Bound copy of the project at the end of each presentation.
- CD containing all project files must be submitted the day of the last presentation, as per school archival guidelines.

Class grade will be based on the following percentages:

40% - Project 1 (part one)

40% - Project 1 (part two)

20% - Attendance and participation to class discussion and individual presentation of reading materials, start-up research, project and editing work.

Late project presentations will not be accepted and will not be graded.

**Class/Student expenses:** book printing by Lulu or equivalent service, book stand for end of the year show (design and fabrication)

## Course Schedule

**01/12 Lecture: Course Overview**

Assignment: Start-up research

Reader: Biomimicry chap 1 – Biomimetic Chapt 1 + find an article on this topic

**01/19 Lecture: Matter and Materials**

Assignment: Intro Project part 1

Pinup: Project 0 presentation and discussion

Reader: TBD

**01/26 What are we made off: the Human Body**

Pinup: review P 1.1

Reader: TBD

**02/02 Lecture: Strong and Flexible: bio-structural materials**

Pinup: review P 1.1

Reader: TBD

**02/09 Field Trip - Caltech LAB visit - Bio-nanomaterials**

**02/16 Lecture: Genetic-tectonics: bio-films**

Pinup: Final Review Project 1.1

**02/23 Final Presentation Project Part 1 - book chapter due**

Assignment: Part 1.2

**03/01 Lecture: Super light, super strong**

Pinup: review P 1.2

**03/08 Lecture: Bio-materials, medical applications**

Pinup: review P 1.2

Reader: TBD

**03/15 Lecture: Field Trip: Museum of Natural History**

Individual Chapter due

**03/22 Field Trip: nanostructured solar cells - LAB visit**

Pinup: book editing review

**03/29 Lecture: Bio-Composites**

Pinup: book editing review

**04/05 Project 1: Book send to print**

**04/12 Book Final Presentation**

*04/20 End of the Year Show: Installation Book display*

NOTE: Subject to change depending upon the progress of the class