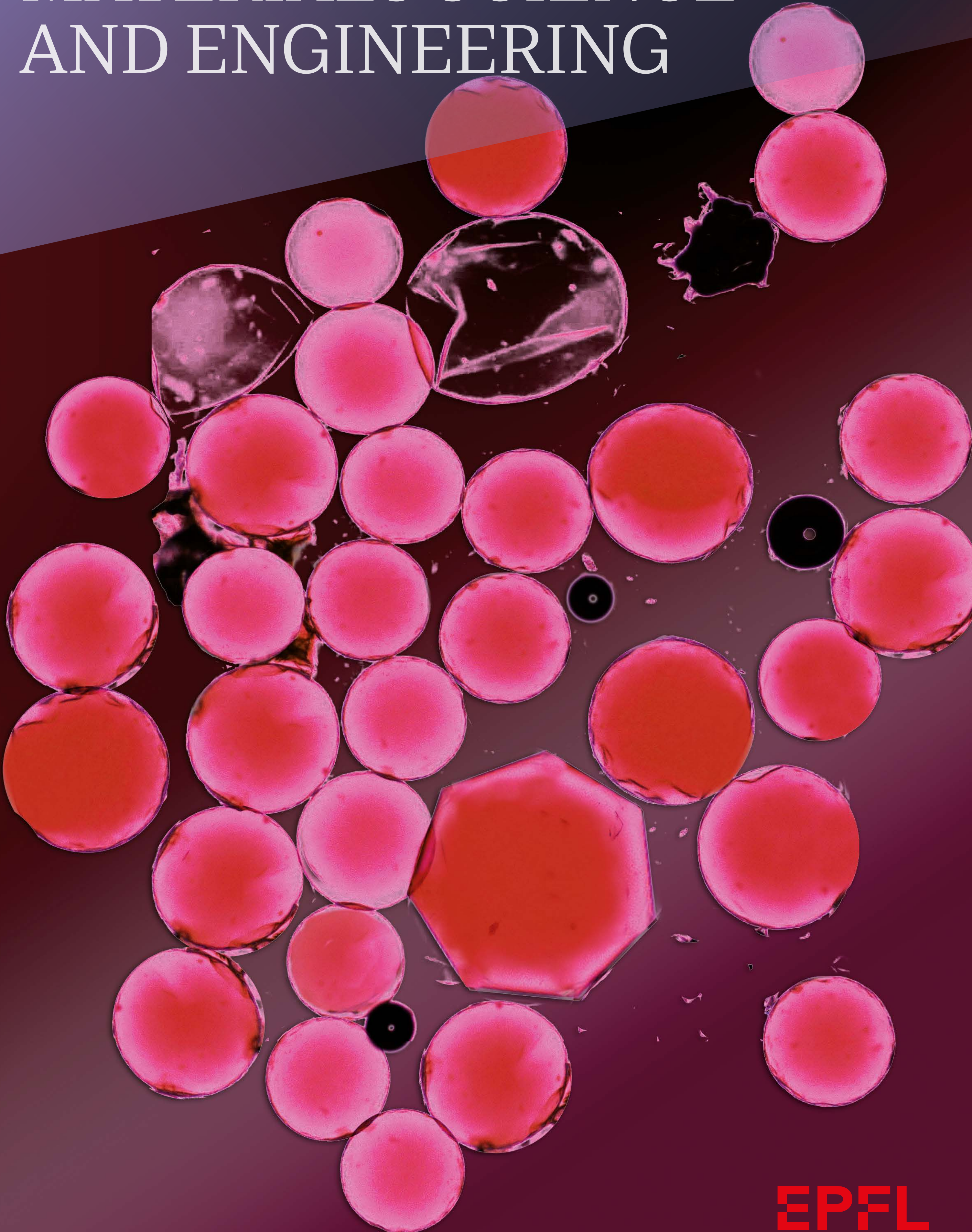
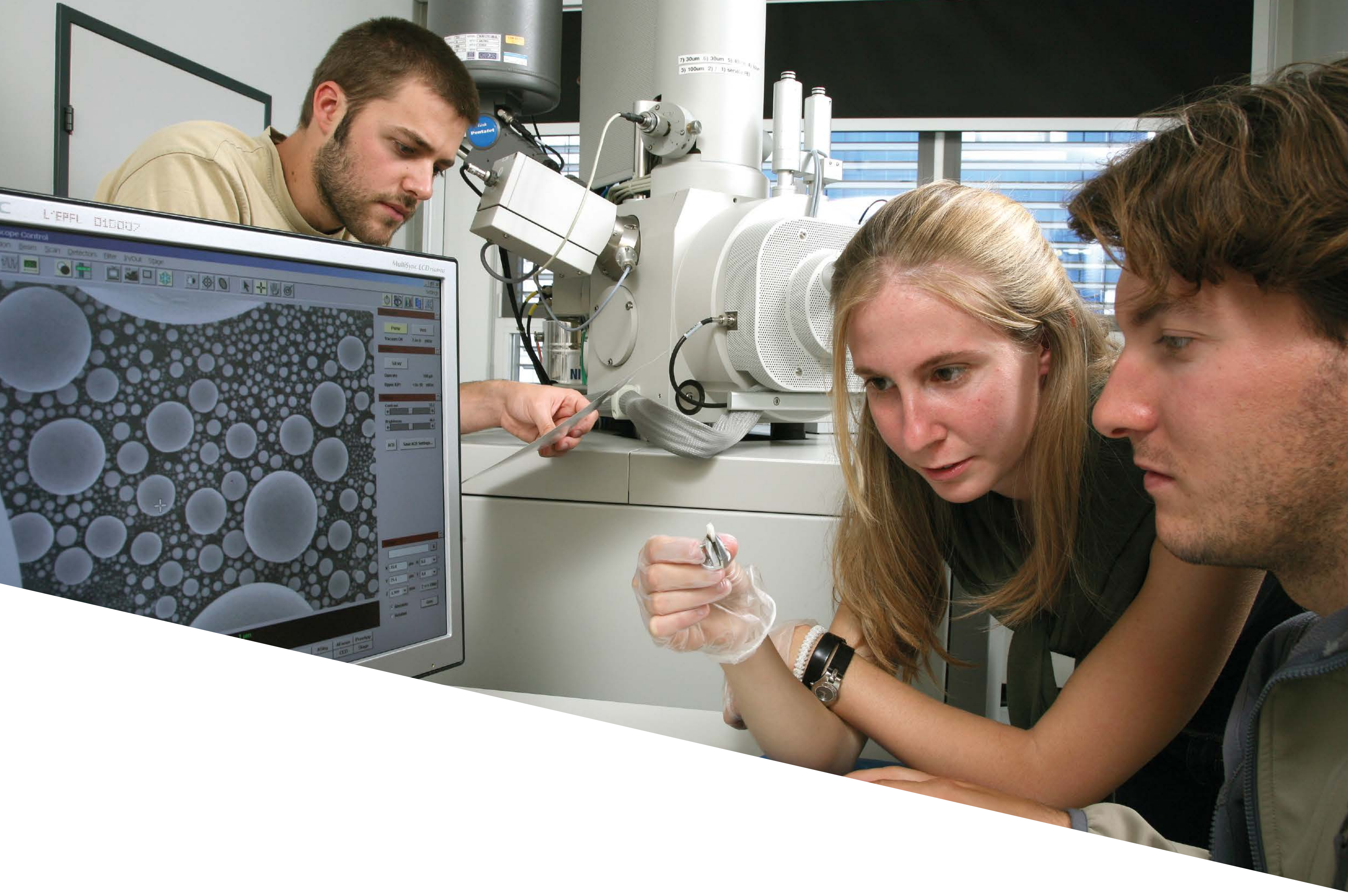
# MATERIALS SCIENCE AND ENGINEERING

MASTER

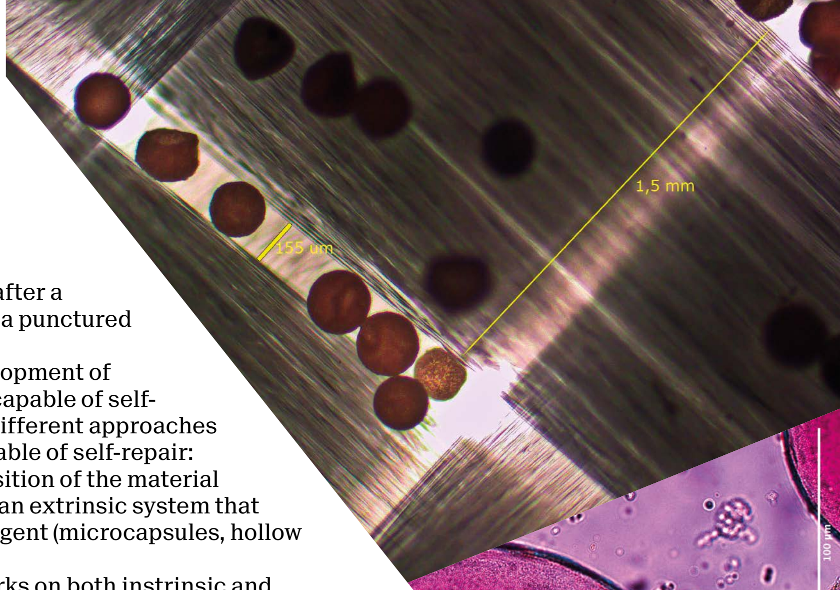


EPFL



The Master in Materials Science and Engineering integrates fundamental knowledge of materials synthesis and processing, materials microstructure and materials properties of polymers, ceramics, metals and alloys, and composites. This knowledge is then used to improve the performance of engineered products and to design unique new materials for next-generation applications, such as optical and electronic materials, and biomaterials with emphasis on sustainable development.

# Materials that repair themselves!




How can we repair an orbiting satellite after a collision with a meteorite, or patch a punctured tire on a desolate road?

The answer may lie in the development of futuristic materials that are capable of self-reparation. There are two different approaches to making a material capable of self-repair: to play with the composition of the material itself or to introduce an extrinsic system that delivers a healing agent (microcapsules, hollow channels, etc.).

At EPFL, we works on both instrinsic and extrinsic self-healing concepts for fiber-reinforced polymer composites.

As an example, epoxy-based carbon or glass fiber composites can be produced with the addition of small capsules in the matrix, that contain a solvent or prepolymer. When a crack appears, the closest capsules break and release the liquid, which may promote swelling or a chemical reaction , fill the gap and reform bonds between the crack faces. This way, small cracks could be repaired before propagating towards a catastrophic damage. Scientists have already managed to heal cracks that appeared in the epoxy resin using capsules filled with ethyl phenylacetate. They also succeeded in stopping the propagation of fatigue cracks. These materials could be useful in constructing devices destined for extremely distant locations, as is the case with satellites, or even weather stations lost in the mountains.

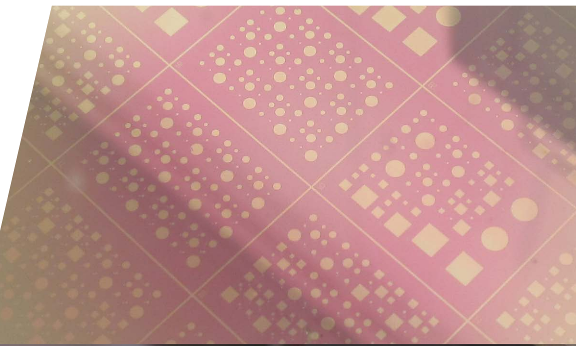
**Watch the video:**

*Hamed Kazemi:*
*"From the earliest civilizations, humanity has been living along side precious metals. But when you look inside those materials you get the feeling that there are still a lot of closed doors... You understand that you can still come up with new ideas, new properties!"*

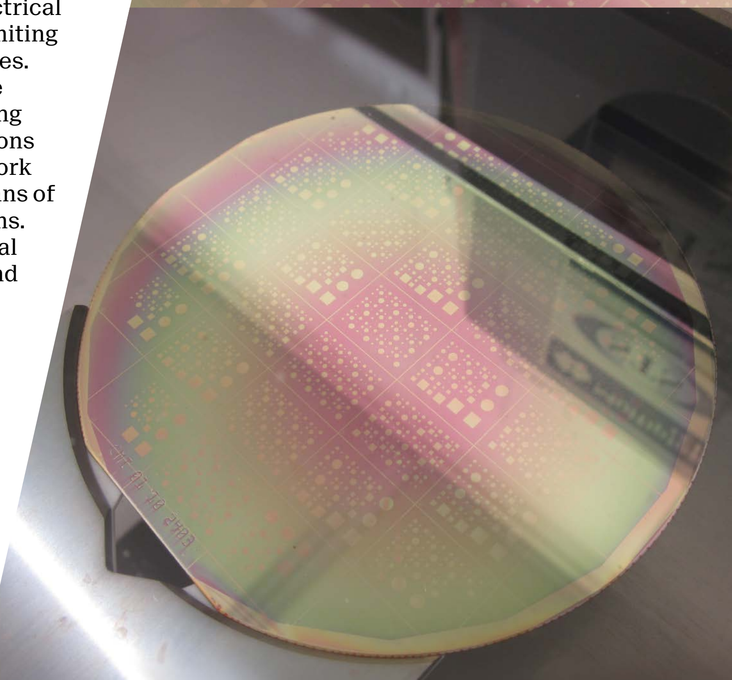
# Piezoelectric thin films for energy harvesting

*Brigitte Greenwood:*
*« Pour mon projet de master, à Singapour, je prévois de travailler sur des vitres photochromiques permettant d'économiser l'énergie utilisée pour refroidir les bâtiments. »*

**Voir la vidéo :**



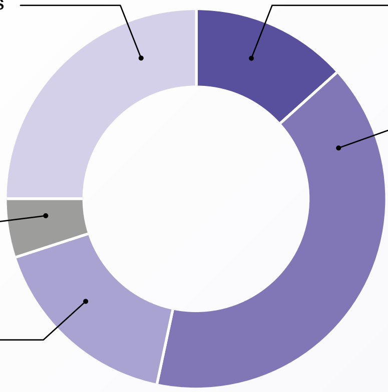
The advent of wireless communication combined with the immense progress in low-power electronics has led to the establishment of wireless networks of dispersed sensors. Such wireless sensor networks are of interest in fabrication facilities, for environmental control, in cars, or airplanes. They are powered by electrical batteries, which are limiting the autonomy of sensor nodes. Large efforts are spent to replace or back-up them with devices harvesting ambient energy. Sunlight, heat, and vibrations may be available from the environment. In our work we investigated harvesting of vibration energy by means of micromachined structures including piezoelectric thin films. Piezoelectric materials develop an electric field upon mechanical deformation. Aluminum nitride (AlN), lead zirconate titanate (PZT), and zinc oxide (ZnO) can be named as the most investigated piezoelectric thin film materials. AlN and PZT are currently the most used materials in energy harvesting since they demonstrate the best combination of coupling factor, mechanical quality and ease of deposition. In our project we determined the effect of scandium (Sc) as substituent of Al in AlN thin films on the output power. We found that the harvesting efficiency is increased by more than 70 % by substituting 14 % of Al by Sc. A doubling of the harvested power efficiency is expected for about 20 % Sc concentration.



Master of Science in

# MATERIALS SCIENCE AND ENGINEERING

2-year program - 120 ECTS




| | Credits |
|---|---|
| **Core courses in materials science** | **16** |
| Advanced metallurgy | 4 |
| Fracture of materials | 4 |
| Fundamentals of solid-state materials | 4 |
| Soft matter | 4 |
| Statistical mechanics | 4 |

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|---|---|
| **Options** | **48** |
| Advanced phase transformations | 3 |
| Assembly techniques | 2 |
| Atomistic and quantum simulations of materials | 4 |
| Biomaterials | 4 |
| Cementitious materials (advanced) | 2 |
| Composites technology | 3 |
| Electrochemistry for materials technology | 2 |
| Electron microscopy: advanced methods | 3 |
| Error control in scientific modeling | 5 |
| Immunoengineering | 4 |
| Introduction to crystal growth by epitaxy | 2 |
| Introduction to magnetic materials in modern technologies | 4 |
| Life cycle engineering of polymers | 2 |
| Light, liquids and interfaces | 4 |
| Material science at large scale facilities | 4 |
| Materials selection | 2 |
| Mathematical methods for materials science | 4 |
| Nanomaterials | 3 |
| Optical properties of materials | 3 |
| Organic electronic materials | 4 |
| Physical chemistry of polymeric materials | 3 |
| Polymer chemistry and macromolecular engineering | 3 |
| Properties of semiconductors and related nanostructures | 5 |
| Recycling of materials | 2 |
| Research project in materials III | 10 |
| Seminar series on advances in materials (autumn) | 2 |
| Seminar series on advances in materials (spring) | 2 |
| Surface analysis | 3 |
| Thin film fabrication technologies | 2 |
| Tribology | 2 |
| Wood structures, properties and uses | 2 |

### Specialization:

**Students may validate the "Materials research and development" specialization by choosing 30 ECTS in the optional courses group**

**Or opt for a 30 ECTS minor included in the 48 ECTS optional courses. Minors recommended with this Master:**

- Biomedical technologies
- Computational science and engineering
- Energy
- Engineering for sustainability
- Management, technology and entrepreneurship
- Mechanical engineering
- Space technologies

### Industrial internship

The program includes a compulsory 8-week to 6-month industrial internship, which can be combined with the Master's thesis.

# Career prospects

A Master's degree in materials science and engineering is the gateway to careers in a wide variety of industries ranging from the production of materials to the manufacturing of finished products such as watches, sports equipment, aeronautic, foods, metallurgy, automobiles, electronics, and multimedia. It also provides an ideal training for the innovative application of advanced materials in areas such as bio- and nanotechnology as well as a strong basis for those who wish to pursue a PhD degree in Materials Science or a related field.


School of Engineering
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