Physics for a sustainable future: the case of the new Master of Materiomics

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Abstract

In 2022-2023, the new Master of Materiomics starts at UHasselt. This program is aimed at students who want to develop sustainable, innovative materials at the interface of physics and chemistry and on the basis of both theoretical/computational and experimental approaches. There are 4 specialization areas: materials for quantum technologies; innovative healthcare; circular processes; and energy. The combination of viewpoints and the boundary crossing nature of the program prepares students for the interdisciplinary teams of the future. As interdisciplinary physics experts, these students will tackle material-related issues in response to societal grand challenges such as climate change and energy transition.

Breakthrough materials development for a sustainable future

At this very moment, society faces complex and intertwined grand challenges, e.g., climate change, pandemics, innovative and safe communication technologies, the energy transition, changing industrial processes, innovative space research and finite resources that are becoming depleted. In response to these challenges, there is a high demand for scientists who are ready for an internationally-oriented and interdisciplinary research environment and labour market. One of the core fields in this respect is materials development and research, as some solutions to the above mentioned complex societal issues may lie in the development of new technologies, of which breakthrough materials development is an important component. Within this context, in 2022-2023, the new Master of Materiomics starts at UHasselt, aimed at students who want to develop alternative, sustainable materials which may help society to remain within planetary boundaries and not to overshoot. To focus the program 4 possible core areas of specialization are defined: Quantum, Energy, Circularity and Health. Flemish students who obtained an academic bachelor in physics have direct access to the master's program, next to academic bachelors in chemistry, biochemistry and biotechnology, bioscience engineering, and engineering sciences. The goal of the master's program Materiomics, is to train interdisciplinary T-shaped professionals, i.e., experts in their field (e.g., physics) who are able to build bridges between the different perspectives involved in materials research and development (cf, Fig. 1). The term 'Materiomics' refers to the holistic study of processes, structures and properties of materials from an exact scientific fundamental, systematic perspective through all relevant scales, from atomic to macroscopic, into the synthesis and functionality. Masters of Materiomics have a solid, broad knowledge base in which the modeling, design, synthesis, properties, and characterization of materials play a central role. Materials are studied from an interdisciplinary perspective, building bridges not only between physics and chemistry, but also between experimental and theoretical methods: Students are taught to

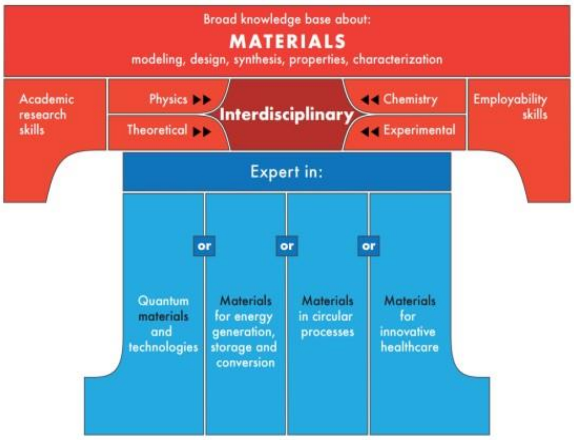

Figure 1: The profile of the Master of Materiomics as an interdisciplinary T-shaped professional.

approach materials from different perspectives and learn to communicate across disciplinary boundaries with experts in chemistry etc., with due attention to academic research skills and soft skills which prepare them for their professional careers. In addition to a broad knowledge base, students acquire in-depth knowledge and skills in one of the 4 areas of specialization: quantum materials and technologies (with applications in cyber security, satellites, medical diagnostics, etc.), materials for energy generation, storage and conversion (from flexible solar cells, over thermochromic glazing to sustainable battery materials), for circular processes, or for innovative healthcare.

Training interdisciplinary physics experts

To obtain these goals, interdisciplinary competences are required: students need to cross boundaries between physics and chemistry, as well as between experimental and theoretical/computational methods. Interdisciplinarity is gradually introduced throughout the curriculum, building on the four learning mechanisms from boundary crossing theory [1, 2], i.e. identification, coordination, reflection and transformation (cf, Fig. 2). More specifically, students are introduced to the different perspectives and approaches, to making connections between different perspectives, synthesizing them (e.g. through assignments, group work...), and applying all this to new, complex material problems (e.g. through a hands-on project, the internship and master's thesis).

Figure 2: The four learning mechanisms of boundary crossing theory [1, 2].

In this lecture, some examples will be presented of how these learning mechanisms can be addressed in different courses and their teaching and assessment approaches [3, 4], to ultimately train experts in physics capable of addressing complex material issues from a holistic approach in multi- and interdisciplinary teams with the necessary attention for aspects such as sustainability, availability of raw materials, recyclability and cost.

References

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