Energy materials and quantum technologies for the future: the case of the Master of Materiomics

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In 2022-2023, Hasselt University inaugurated the Master of Materiomics program. This study program targets individuals aspiring to pioneer sustainable and groundbreaking materials situated at the intersection of physics and chemistry, utilizing both theoretical/computational and empirical methodologies. The curriculum delineates four specialized domains, of which two will be highlighted in this contribution: Innovative materials for energy generation, storage and efficiency; and high-tech materials for quantum technologies. By combining diverse perspectives and fostering interdisciplinary engagement, the program cultivates students ready for interdisciplinary collaborations in the work field. Moreover, there is a continuous need for these advanced physics profiles in industry and academia (*e.g.*, Einstein telescope). Equipped as interdisciplinary scientists, students are trained to address material-related challenges pertinent to overarching societal imperatives such as climate mitigation and the transition towards sustainable energy paradigms, but also to scientific progress in *e.g.* cyber security and innovative space research.

Introduction

In the current times, society deals with a myriad of complex and interconnected challenges such as climate change, pandemics, the advancement of secure communication technologies, the transition towards sustainable energy sources, evolving industrial processes, pioneering space research, and the depletion of finite resources. In response, there is a pressing demand for scientists who are well-equipped to navigate an internationally-focused and interdisciplinary research landscape, as well as the corresponding job market. Central to addressing these challenges is the field of materials development and research, as the search for solutions often depends on innovation and breakthroughs in this domain.

Breakthrough materials for energy

The Energy specialization of the Master of Materiomics provides in-depth training in developing and characterizing innovative, high-performance materials for renewable energy generation/storage and CO_2 emissions reduction. This pillar is aimed at students interested in improving photovoltaic energy conversion, materials for thermochromic glazing that can switch between heat pass/block, designing short- and long-term battery materials, green hydrogen via water dissociation,... Here students will address questions such as "How can we increase the efficiency of the new generation of solar cells?" or "How can we convert CO_2 into usable fuels using sunlight? Reducing CO_2 emissions but certainly also capturing, converting and rendering CO_2 usable (CCU) are technological innovations in which the master can play an important role. In sum, students in the Energy specialization pillar are trained in the design, improvement and characterization of renewable materials for energy applications such as batteries, solar cells, and hydrogen cells. There is demand for such profiles by companies active in materials development specifically for these applications (*e.g.*, Umicore) as well as in research centers such as Energyville, imec, and VITO. Moreover, masters with expertise in innovative energy materials and applications can also contribute to the Einstein telescope project, *e.g.* to make it more sustainable.

High-tech materials for quantum applications

The quantum specialization pillar immerses students in state-of-the-art emerging technologies that can force breakthroughs in cybersecurity, computational power, metrology, sensitivity of sensing instruments for medical diagnostics, and much more. Students research the technology used in high-tech quantum sensors for *e.g.* NMR instruments or magnetic field sensors for space that outperform classical sensors. A well-known example in this respect is the UHasselt Oscar Qube project [1], in which ESA sent a student-built quantum magnetometer to the ISS. Another example is the recent development of promising methods by quantum physicists to reduce quantum noise in the Einstein telescope so its measurements will be 100 times more precise [2]. In addition, these materials are also of interest for future quantum computers, which are capable of solving problems unsolvable by classical computers and can play a major role in the search for new materials, encryption, security and transmission of data, among other things.

Interdisciplinary skills for the work field

In addition to this specialized knowledge, students are taught to adopt diverse viewpoints when engaging with materials and are trained to effectively communicate across disciplinary boundaries, collaborating with experts in fields such as chemistry [3]. Emphasis is placed on cultivating both academic research abilities and soft skills, thereby equipping students with the necessary tools for their future professional roles. These interdisciplinary skills have been emphasized repeatedly by employers in the field.

References

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