

ICT PHD

Research project for a PhD curriculum in ICT – Electronics and Telecommunication

Tutor: Davide Barater

Co-tutor: Stefano Nuzzo

Foreign Co-tutor: Chris Gerada (The University of Nottingham UK)

Proposed Title of the research: High Performance rare earth free Electric Motors for a sustainable and greener transportation

Keywords: (5) Electrical machines, power density, Sustainability, Torque density, Green transportation

Research objectives: --(max 10 rows)

In the last years, the need for high power density and efficiency has become a central concern in the green transportation sector. Electrical machines based on permanent magnets have gradually replaced more traditional solutions in the automotive and transportation sectors.

This has led to concerns about rapid depletion of rare earth resources. The situation is aggravated by a geographical concentration of these strategic materials and a dependence of a strategic sector on countries with a high risk of reliability. In addition to this, sustainability aspects of material used for motor windings has favoured the research of aluminium alloys thanks to its light-weight characteristic and flexibility in manufacturing

Due to these economic, environmental, and geopolitical problems, industry is exploring different technologies based on materials are more compatible from an environmental point of view and with greater availability to avoid jeopardizing the transition to electric mobility, which promises to reduce by 75% greenhouse gas emissions due to transport, and the production of electricity from renewable sources.

Proposed research activity -- (max 10 rows)

To ensure efficiencies close to machines that use rare earth magnets, it is necessary to develop a machine with high differences in inductance values in the d-q axes. The design of the machine will have to foresee high speeds to increase the power without excessively increasing its performance and this will require the study of new devices/materials to reduce the losses in iron and copper. The machine design must also consider the manufacturing process to reduce the environmental impact. The objectives proposed for this research project are therefore set as follows.

State of art on the design of Rare-Earth free electrical machine, selection of best material candidates to replace Rare-Earth in Permanent Magnet, investigation of aluminium as best candidate to replace copper in machine windings, multi-physics design approach, FEM analysis for machine torque and power prediction, prototyping and experimental verification an optimized design of electrical machine.

Supporting research projects (and Department)

The successful candidates will become part of the MeltingLab research team, working of electrical machines and converters of the University of Modena and Reggio Emilia.

Possible connections with research groups, companies, universities.

The project will see the involvement of the University of Nottingham UK (UoN), which will participate in the study and electromagnetic analysis of the proposed electrical machine. Dual Degree with UoN is possible as well.