

## Characterization of bulk rare-earth permanent magnets with complex geometries

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Rare-earth (RE) permanent magnets are ubiquitous across a wide range of market sectors, from energy to information technology. The security of the raw materials used in the production of these permanent magnets is of critical importance to the low carbon future envisioned by the European Union. The Horizon 2020 project Resource Efficient Production of Magnets (REProMag <http://www.repromag-project.eu/>), looks to address the problem of the sustainability of RE permanent magnets by developing an innovative automated manufacturing route. The Shaping, Debinding and Sintering (SDS) process being developed will allow economically efficient production of net shape magnetic parts with complex structures and geometries, while being 100% waste free through the use of fully recycled raw material. As part of this project, a series of demonstrators will be produced, each with a very complex geometry making traditional material characterization impracticable. Electromagnet methods suffer from limitations on space and flux leakage from induced air gaps. The National Physical Laboratory (NPL) is working towards a new measurement standard to overcome these limitations and allow material characterization throughout the production of the complex components. Pulsed Field Magnetometry (PFM) discharges a current from a capacitor bank at 50 and 25 Hz to create large magnetic fields inside a solenoid, with smaller coils used for the detection of magnetic field and polarization. The large sample space allows for the characterization of complex, real-world components with a maximum lateral dimension of 50 mm at operational temperatures up to 200 °C. In comparisons against an electromagnet, PFM has shown good agreement with the measurement of remanence, but discrepancies with other important parameters such as coercivity and energy product. This work will discuss NPL's current investigation of the physical effects (such as self-demagnetization and Eddy currents) behind these discrepancies.