

Master

Betreuer: Siddique Akbar
 Telefon: +49 (0) 511 / 762-5616
 E-Mail: Siddique.akbar@ial.uni-hannover.de

Fachgebiet für Elektrische Maschinen
 und Antriebssysteme
 Prof. Dr.-Ing. Bernd Ponick

Hybrid Rotor Design in SynRM: Combining Multi-Material Additive Manufacturing with Embedded Permanent Magnets for Performance Enhancement

Synchronous Reluctance Machines (SynRMs) offer a magnet-free rotor structure and simple construction but performance is typically limited compared to PM SynRMs by low torque density, moderate efficiency, and poor power factor. To overcome these limitations, two advanced strategies have been explored: Multi-Material Additive Manufacturing (MMAM) and Permanent Magnet Assistance (PMA).

MMAM enables the integration of magnetic and non-magnetic materials within complex rotor geometries. The inclusion of non-magnetic regions such as 316L stainless steel helps guiding the magnetic flux and reduces the quadrature-axis inductance (L_q). This improves the saliency ratio (L_d/L_q), thereby enhancing both torque capability and power factor. PMA-SynRMs further boost performance by embedding cheap ferrite permanent magnets into the rotor, providing additional torque and improving the machine's electromagnetic response, especially under low-speed.

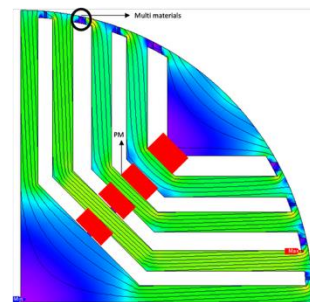


Figure 1. Rotor of SynRM

This thesis shall investigate a hybrid rotor design that combines both concepts. Using multi material additive manufacturing, embedded permanent magnets centrally to assist torque production, while non-magnetic materials are placed at the rotor edges to reduce the leakage flux and q-axis inductance.

The objective is to evaluate how this integrated rotor architecture affects torque production, torque oscillations saliency ratio, power factor, efficiency, and electromagnetic losses, compared to conventional MMAM-only and PMA-only SynRM designs.

Task for Student

- **Literature review:** SynRM principles, MMAM techniques, and PM assistance.
- **Design:** Hybrid rotor in CAD.
- **Simulation** (JMAG/FEMM): Torque, L_d/L_q , losses, efficiency vs. MMAM-only, PMA-only, and hybrid.
- **Evaluate** performance vs. manufacturing complexity and PM thermal/demagnetization risks.

Forschungsschwerpunkt:

Elektromobilität / Aviation

Großmaschinen

Industrieantriebe / Mechatronik

Inhalt:

	viel					wenig		viel					wenig
Methodenentwicklung	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		Programmierung	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Maschinenentwurf	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		HF-Effekte	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
FE-/Systemsimulation	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Geräusche / Schwingungen	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	