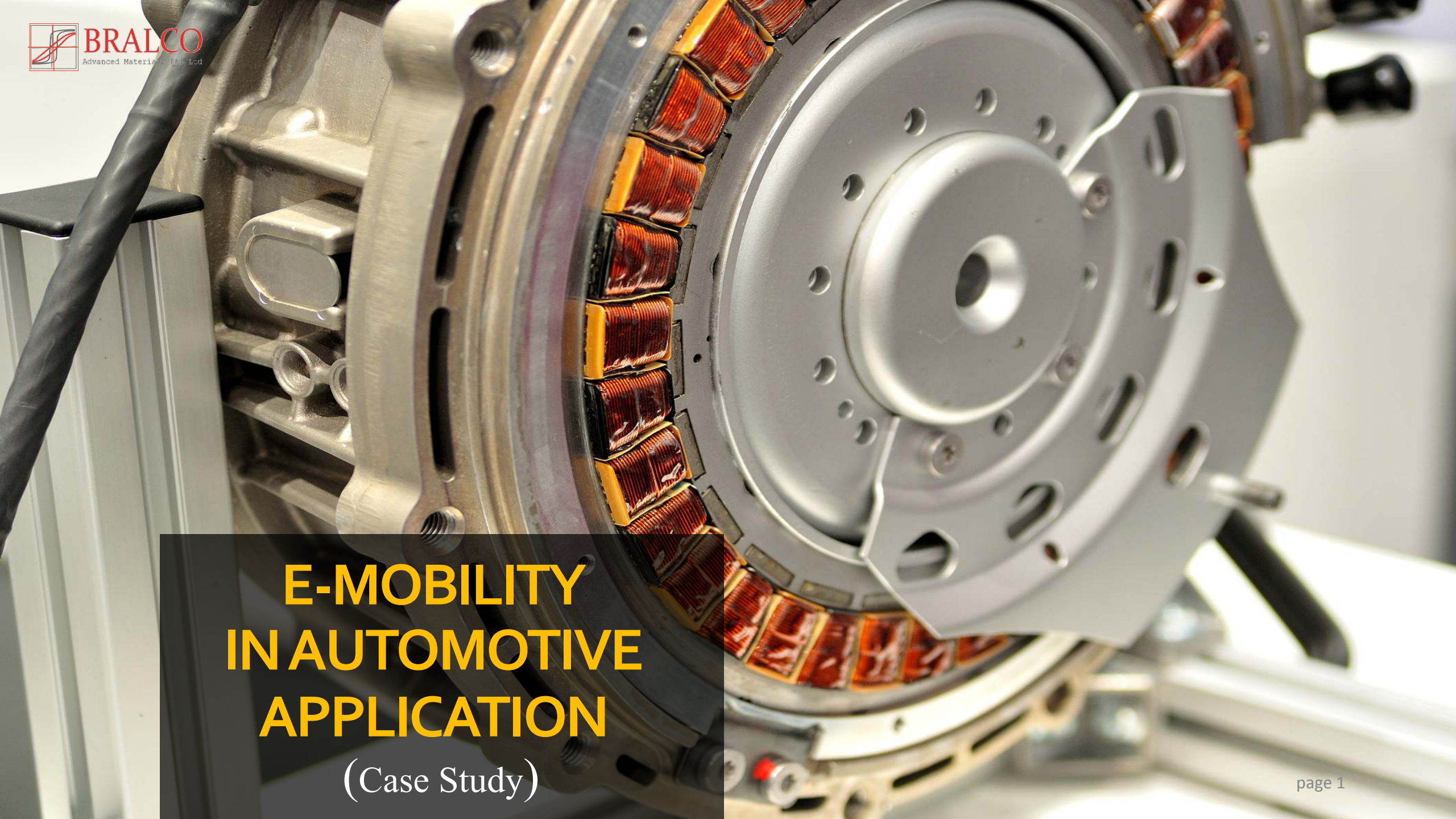
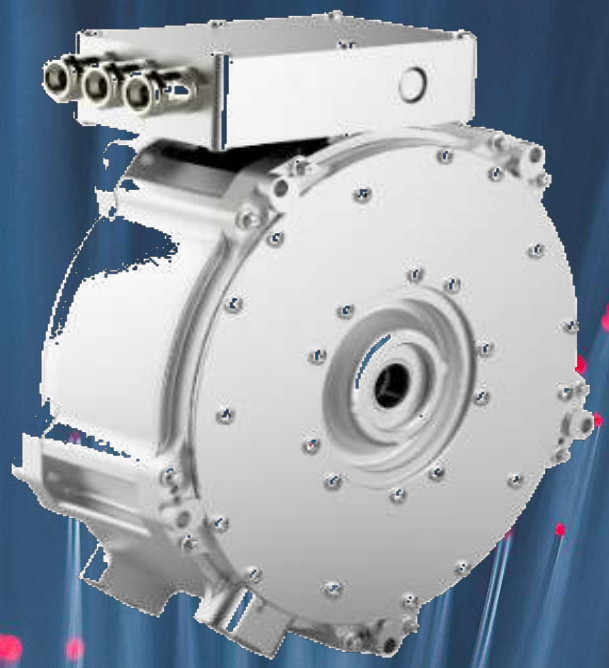


BRALCO
Advanced Materials Pvt Ltd

E-MOBILITY IN AUTOMOTIVE APPLICATION

(Case Study)



AXIAL FLUX PERMANENT MAGNET MOTOR

Challenges: Fabricate the stator core of an AFPM.

Reason: The slow uptake and demand of the axial flux technology is due to the lack of suitable materials and manufacturing processes.

Ideal Characteristics of a Stator Core

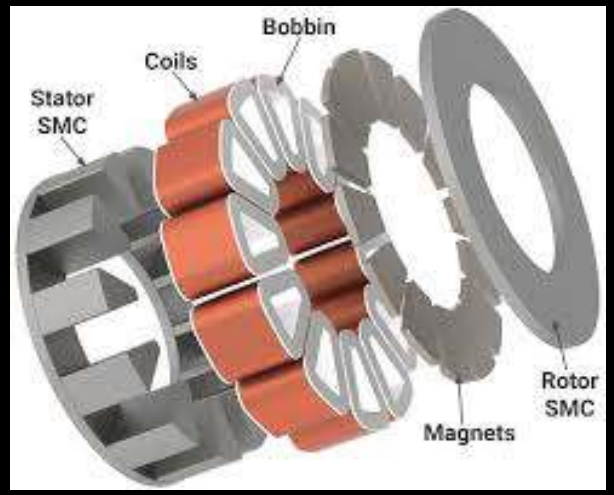
- High permeability, saturation induction
- Isotropic flux
- Low total losses even at high frequencies
- High mechanical strength of stator and rotor
- Conformal cooling channels
- Low aspect ratio - Length-to-Diameter ratio
- High slot fill factor

DESIGN PARAMETERS AND FEATURES OF AFPM

Single air gap or multiple air gaps machines, with slotted, slotless or even fully ironless armature.
We can offer additive manufacturing solutions for single air gap assembly.

Typical Axial Flux PM Motor Specifications

Motor variant	AF125	AF130	AF140	AF230	AF240
Maximum Speed (rpm)	12,000	8,000	5,000	8,000	5,000
Nominal Torque (Nm)	100	145	260	290	520
Peak Torque (20s) (Nm)	220	350	600	700	1,200
Nominal Output Power (kW)	59	64	94	128	188
Peak Output Power (20s) (kW)	100	140	220	280	440
Peak Efficiency (%)	96				
Dimension (LxD) (mm)	110x258	110x300	110x380	212x300	212x380
Weight (Kg)	22	30.5	42.5	57.5	82



- Very high torque and power density
- Low cogging torque
- Power density of >10kW/Kg achievable
- Compact design with flat front & back faces for mounting
- Low inertia composite rotor with excellent rotor dynamic stability
- Through shaft and customised versions available.
- Peak efficiency: >96% (Includes power inverter)
- Voltage: up to 800 VDC
- Water/glycol cooled for simplified installation & enhanced performance

LIMITATIONS OF CURRENT DESIGN PARAMETERS AND FEATURES OF AFPM

Major pain points in manufacturing AFPM

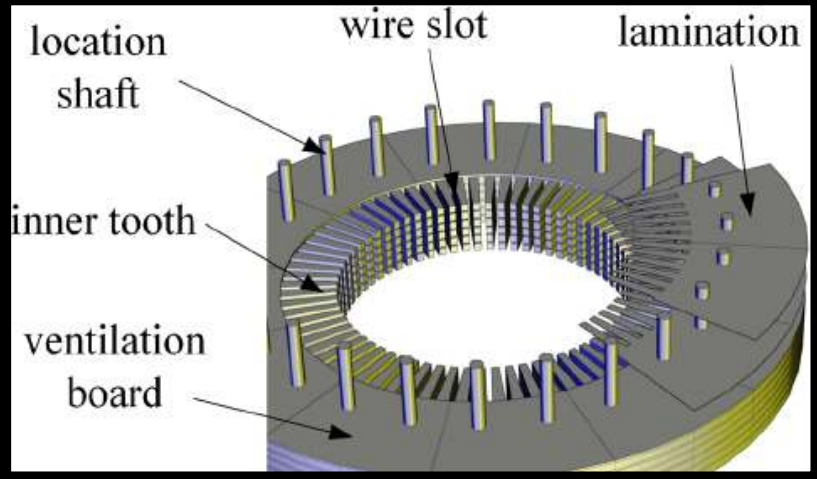
- Strong axial magnetic force between stator and rotor.
- Fabrication difficulties.
- Longer manufacturing time.
- High thermal hotspots.
- High cost for small batch production.

Our Solution

-3D isotropic flux
-Low hysteresis losses
-Additively manufactured into one solid component
-Finite Element Method (FEM) Analysis and Topology Optimization (TO)

Technological Limitations of Lamination

- Anisotropic direction
- Limited to simple 2D core construction
- Large eddy current losses at high frequencies (>400Hz)generating excessive heat thus it is not suitable for AFPM
- High material wastage



OUR PROPOSED SOLUTION

Additive Manufacturing of the Stator Core

To redesign and remanufacture stator cores of higher torque-to-weight ratio, energy density and improved thermal and magnetic properties.

- Unprecedented design freedom- Manufacturing internal complex features such as conformal cooling channels.
- Miniaturization- Compact and reduced weight to volume ratio of parts.
- Laser strategy- redesigning complex structured components with controlled microstructure and magnetic properties, structure-property relationships.
- Topology optimisation (TO)- the potential for performance improvement through Geometry design.

SUMMARY

AM has the potential to open the path to a new generation of high torque-to-weight components.

Therefore, we intend to improve the existing design of stator cores using AM technology.

REENGINEERING COMPONENTS OF TOMORROW