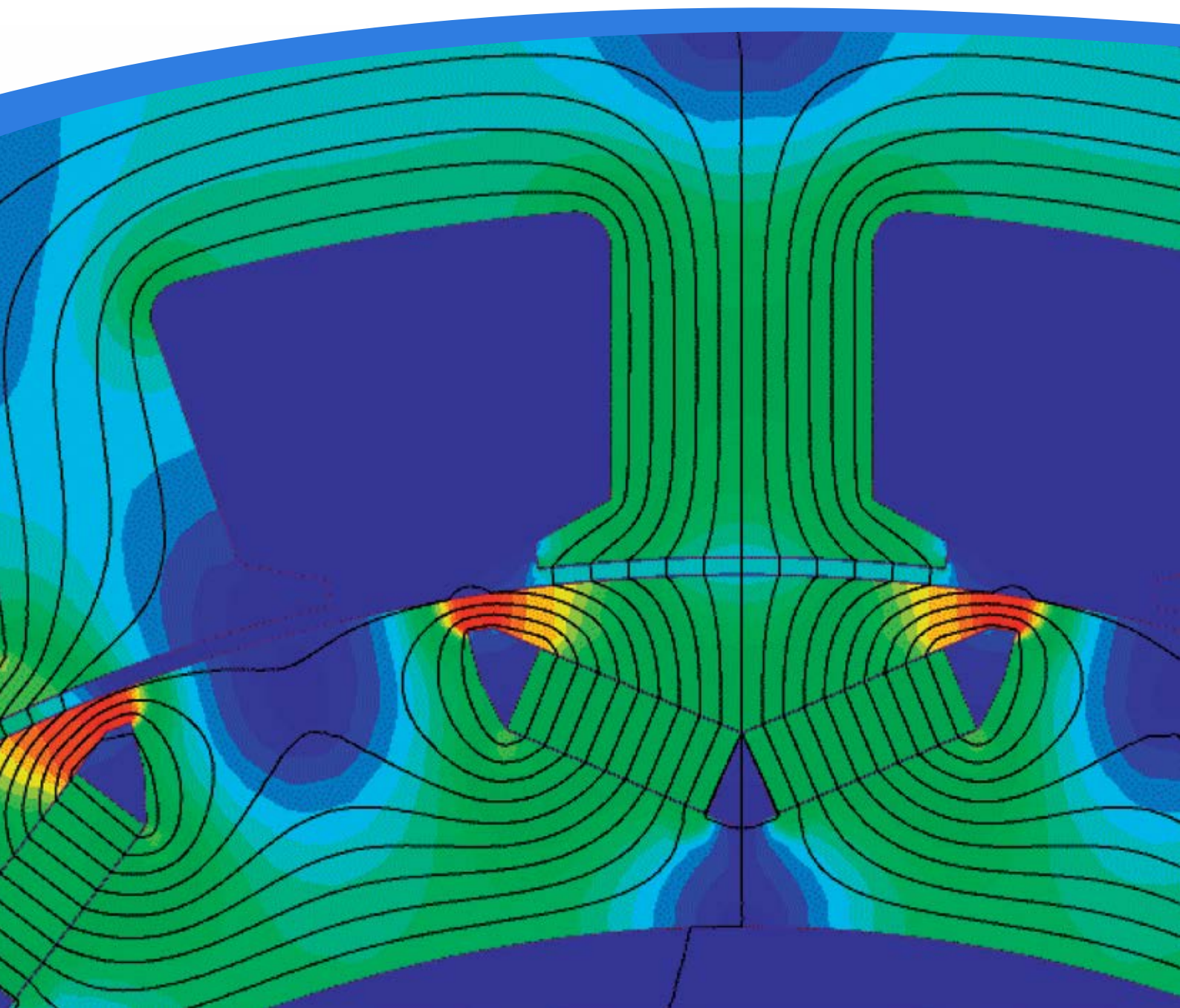


TATA STEEL



Electrical steels for low carbon vehicles



A close-up, low-angle shot of a car's front end, focusing on the headlight and the hood. The car is dark, possibly black or dark blue, and the lighting is dramatic, highlighting the curves and textures of the metal. The background is dark, making the car's details stand out.

WORKING TOGETHER TO DELIVER WORLD LEADING TECHNOLOGIES

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Tata Steel is one of the world's top ten steel producers, and our European operations comprise Europe's second largest steel producer. We serve many different and demanding markets worldwide, including aerospace, automotive, construction, energy and power, and packaging.

Innovation and continuous improvement are at the heart of our performance culture. We aim to create value by offering a sustainable and value-added steel product range supported by unrivalled customer service.

For the low carbon vehicle sector, we offer the most comprehensive range of products and services to meet your demands. Together with our partners we are able to provide a complete service from system design and testing through to supply chain development.

Utilising our advanced materials, technical services and partnerships, we can work with you to deliver world leading technologies optimised for performance, cost and manufacturability resulting in a lower total cost of ownership (TCO).

SOLUTIONS THAT DELIVER

At Tata Steel we recognise the challenges you face. We offer an unrivalled range of high quality products and integrated services so that we can work successfully in partnership with you to deliver your business requirements.

Products that perform

Our extensive range of steel products provide more opportunities to optimise powertrain designs and lower total cost of ownership by understanding the interaction of the materials as well as understanding the individual materials themselves. Whether it's high strength steels that will allow lighter weight, or higher cleanliness for longer life, our products offer you the flexibility to tailor your power train to your requirements.

Steel remains at the core of even the most extreme engineering solutions developed for low carbon vehicles.

The images below show just some of the technologies which we have worked on to help deliver the right material solutions for their performance needs. Working with these technologies from even the early prototype stages helps us understand the opportunities for steel in the future and deliver the right new material and service solutions when they are needed.

Emissions targets

Our range of products and services will help you with every aspect of meeting the emissions targets laid down by governments across the globe.

Our Speciality Steels enable powertrain efficiencies to be improved, downsizing to be achieved and cost effective next generation solutions to be delivered to market. Our electrical steels meet the requirements of all types of electric motors from permanent magnet technologies through switch reluctance to induction motors and generators.



Turbine range extender



Rotary ICE range extender



EV transmission



Electric turbocharger



Electric motor



Flywheel KERS



Bringing technology from prototype to production

Our comprehensive range of services support our material capabilities to help ensure the technologies will perform as required for the duration of the vehicle life, will be as recyclable and energy efficient as possible in production, and as cost effective to produce as the best in class today. Our range of services include:

- Mechanical Analysis (strength, fatigue & crash)
- Electromagnetic Analysis (in combination with mechanical analysis of motor design)
- Value Analysis (design & material reviews for the optimum cost, weight & performance balance)
- Manufacturing process analysis (optimised process route and the material & performance implications)
- Advanced material data and the opportunity to do bespoke testing.



We are continually improving our products and services and striving for excellence in customer service.

ELECTRICAL STEELS

Cogent, a Tata Steel Enterprise, offers a comprehensive range of electrical steel grades and services for manufacturers and designers of low carbon vehicles.

Low losses at high speeds

In order to save weight and reduce package space, electric motors for Hybrid Electric Vehicles (HEV) and Electric Vehicles (EV) are now being designed to work at higher rotational speeds. With rotational speeds up to (and sometimes higher than) 10,000 rpm, and with six or more poles, frequencies of the varying magnetic flux in the core of the motor can reach up to 1000 Hz or more. To obtain low losses at these high frequencies a thin gauge grade is necessary.

We have the widest range of thin gauge grades in the market.

Steels with guaranteed mechanical strength

Electrical steels normally do not have any guarantees on mechanical strength. The industry standards for electrical steels do not give any guidance at all in terms of values for the mechanical performance. However for fast rotating machines, and in particular for rotors with "very narrow" load bearing parts (e.g. internal permanent magnet rotors), the strength of the material is an important factor. Therefore we offer a number of grades with guaranteed mechanical strength levels.

Combined with our service offerings we can offer guaranteed mechanical properties combined with detailed fatigue and durability analyses.

Thin gauge electrical steels for high speed machines

Grade	Thickness (mm)	Max P _{10/400} (W/kg)	Max P _{10/2500} (W/kg)	Typ P _{10/400} (W/kg)	Typ R _{p0.2} (MPa)
NO10	0.10	13.0	135	12.1	400
NO12	0.12	13.5	152	11.8	400
NO15	0.15	14.0	-	12.1	400
NO18	0.18	14.3	179	12.3	400
NO20	0.20	15.0	215	12.2	400
NO27	0,27	15,0	-	13,0	-
NO30	0,30	17,0	-	15,9	400

Electrical steels with guaranteed mechanical properties

Grade	Thickness (mm)	Min R _{p0.2} (MPa)	Typ R _{p0.2} (MPa)	Typ P _{15/50} (W/kg)	Typ P _{10/400} (W/kg)
M330-35HT	0.35	320	340	2.94	23.5
M330-35HS	0.35	330	380	2.94	18.8
M250-35HS	0.35	400	455	2.35	17.1
NO50	0.50	400	450	-	24.0



A product range to meet all needs and services to match

A special electrical steel grade may not be necessary for all motor designs for HEV/EV. The following table lists a number of standardised electrical steel grades which may be of interest for low carbon vehicles.

Supporting all these material solutions we are able to offer a comprehensive range of services:

Standard electrical steel for high efficiency motors

Grade	Thickness (mm)	Max P _{15/15} (W/kg)	Typ P _{10/400} (W/kg)	Typ R _{P0.2} (MPa)
M235-35A	0.35	2.35	16.9	460
M250-35A	0.35	2.50	17.1	455
M270-35A	0.35	2.70	17.3	450
M300-35A	0.35	3.00	18.8	370
M330-35A	0.35	3.30	23.5	315
M250-50A	0.50	2.50	23.4	475
M270-50A	0.50	2.70	24.1	470

Durability design

We have extensive experience of designing automotive components for durability using real load cycles. We have applied this knowledge to electric motors to allow us to deliver not only great electromagnetic performance but also a long service life for any products using our materials.

Test data

We have a comprehensive range of data on the magnetic, mechanical and physical properties of electrical steels which can be provided on request. With very well equipped test laboratories and cooperation with world leading universities there is always the possibility to get the data you need.

Bespoke Grade Development

Utilising our in-house supply chain and research and development resources, we are able to develop customer specific grades for larger volume applications. We also have extensive knowledge on coatings, lamination and core manufacturing.

www.tatasteel.com

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