中国车用驱动电机系统的研发和产业进展

State-of-the-art Technology & Industrialization of EV Motor Drive System in China

Expert Panel for Efficient and New Energy Vehicles Project of 863 Program

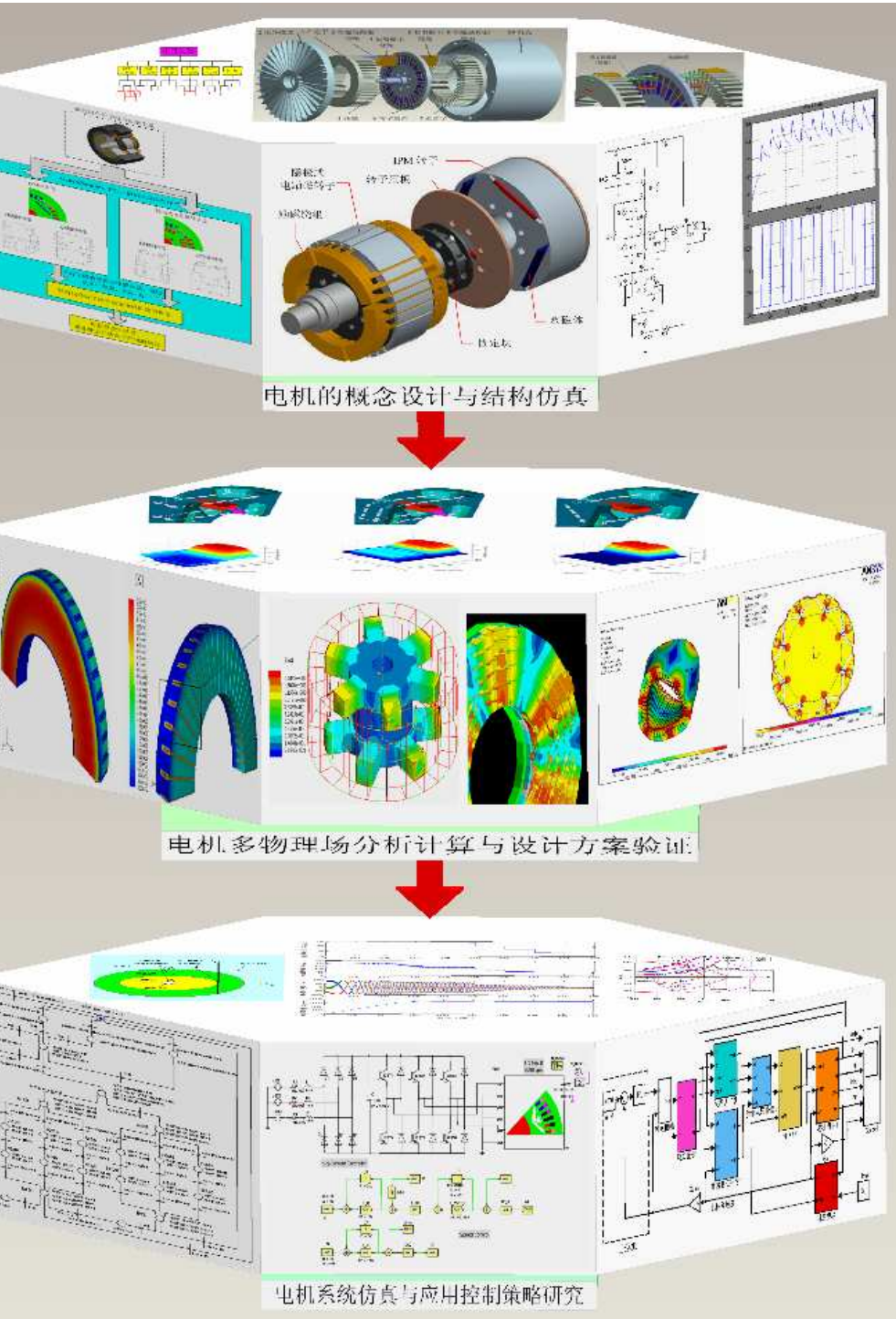
主要内容 Table of contents

1、我国车用驱动电机系统发展现状

Development status of EV motor drive system in China

2、面临的挑战、趋势和主要工作举措

The existent challenges、development trends and corresponding measures



现代设计理念与方案得到有效验证

Modern design ideas and scheme are verifie

- 用现代车用电机系统设计理念，解决多目标高性能车用电机的极限设计与多领域精确分析以及结合应用控制策略系统集成仿真的深层处技术难题；

  By use of modern design theory, key techniques having been break through such as optimize design, accurate multi-subjected analysis and integrated simulation.

- 车用驱动电机满足了节能与新能源汽车对高效率、高密度的的应用需求，经过电机测试基地的统一测试，大多数技术指标达到了整车提出的要求。

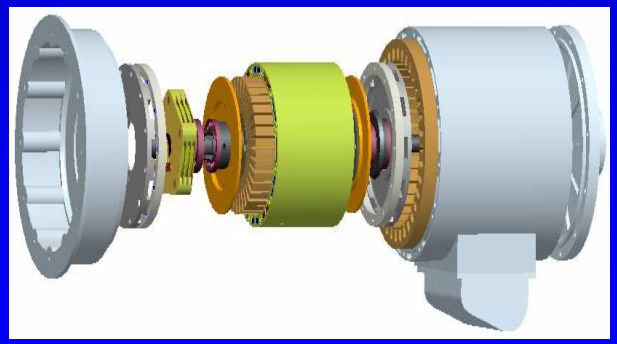
  All kinds of electric machines have meet the requirements of EV in high efficiency and high density. Most of

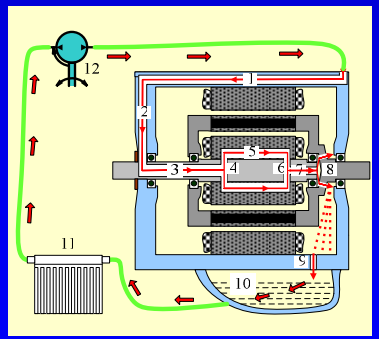
新原理、新技术产品开发

R&D on products with new scheme and new technology

国内部分企业、研究单位和高校对一些新原理的电机系统，例如基于双机械端口电机的电力无级变速系统（EVT），混合励磁电机系统等，进行了积极研究探索，有些已作出了样机，有的进行了台架试验和装车。

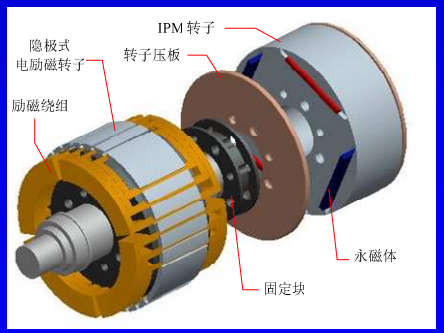
Some enterprises 、research institutes and universities in china have developed some electric machine with new scheme, such as EVT、hybrid excitation electric machine etc, and have manufactured some prototypes, some of the prototypes have passed test on the test platform, and some have been equipped in the vehicle.

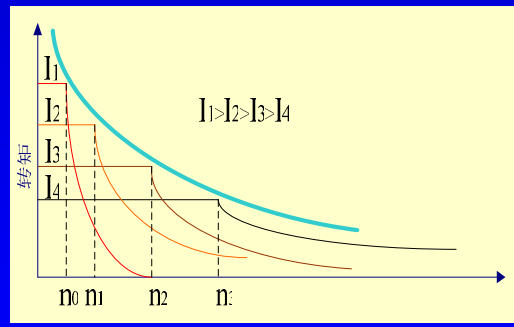




双机械端口电机的电力无级变速系统

EVT





混合励磁电机系统

Hybrid excitation electric machine

部分关键共性技术研究取得突破

Breakthrough on primary and common technique

车用驱动电机系统产品链部分共性基础技术，如满足各种整车封装需求的电机转子位置传感器、绝缘材料、永磁材料取得了突破，并在上车的电机产品中得到了良好的应用。

Some common and primary technique of electric machine have received breakthrough, such as rotor position sensor、insulation materials、permanent magnet materials etc, which have been put into application in motor products successfully.

高可靠速度位置传感器

Speed and position sensor with high reliability

高性能稀土永磁材料

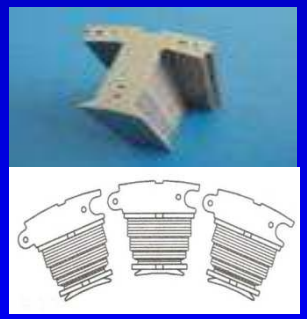
Lanthanum permanent magnet with high performance

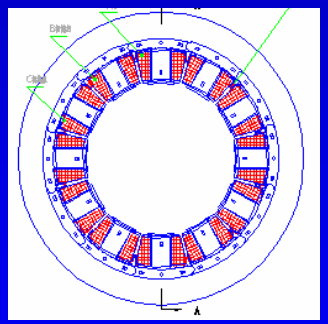
关键制造工艺成果成功应用工程实践

Successful application on primary manufacture technology

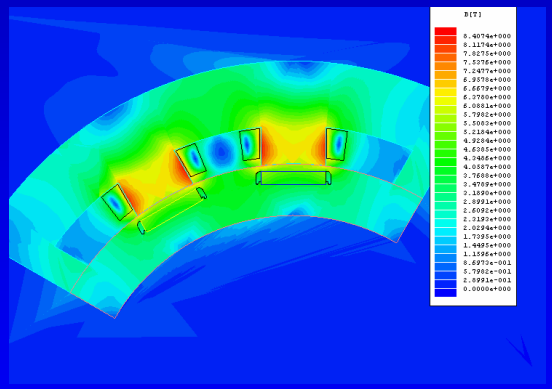
对车用电机制造工艺进行了有益的研究探索，如拼块式铁心、高密度的绕线技术和整体充磁工艺等已开始用于产品实践。

Research on some manufacture technology of electric machine have been carried out, some achievements such as segmented stator, wiring technology with high density and unitary magnetization have been used in electric machine products successfully.





拼块式定子铁心与高密度绕线技术
Segmented stator technology and high density wiring technology



整体充磁工艺技术
Unitary Magnetization technology

充磁设备研究
Magnetization equipment

规范产品技术标准
Formulate products’ test rules

- 重大专项办公室对整车的需求和应用、电机系统单位的研制和生产进行调研；
  The national EV project management office convoked investigation on the demands and application of vehicle、development and production capacity of electric machine field.
- 整车单位和零部件进行技术对接和研讨，重点讨论电气接口、机械接口统一性；并对可靠性评价测试方法进一步针求整车企业意见；
  Discuss focused on the unification of electric interface and mechanical interface has been carried out by vehicle enterprises and e-motor enterprises, and advice on reliability test rules has been consulted.
- 组织中国汽车技术研究中心和电机测试基地，结合目前的整车发展需求，提出并上报有关标准修改建议书，为制定和修改标准做好准备。
  China automotive technology & research center and test organ for electric machine test have been convoked to present proposals to revise and formulate related rules, incorporating with current development demands of vehicle, and to prepare for revision.

产品功能和性能基本满足整车要求

Function and specifications of product meet demands of vehicle





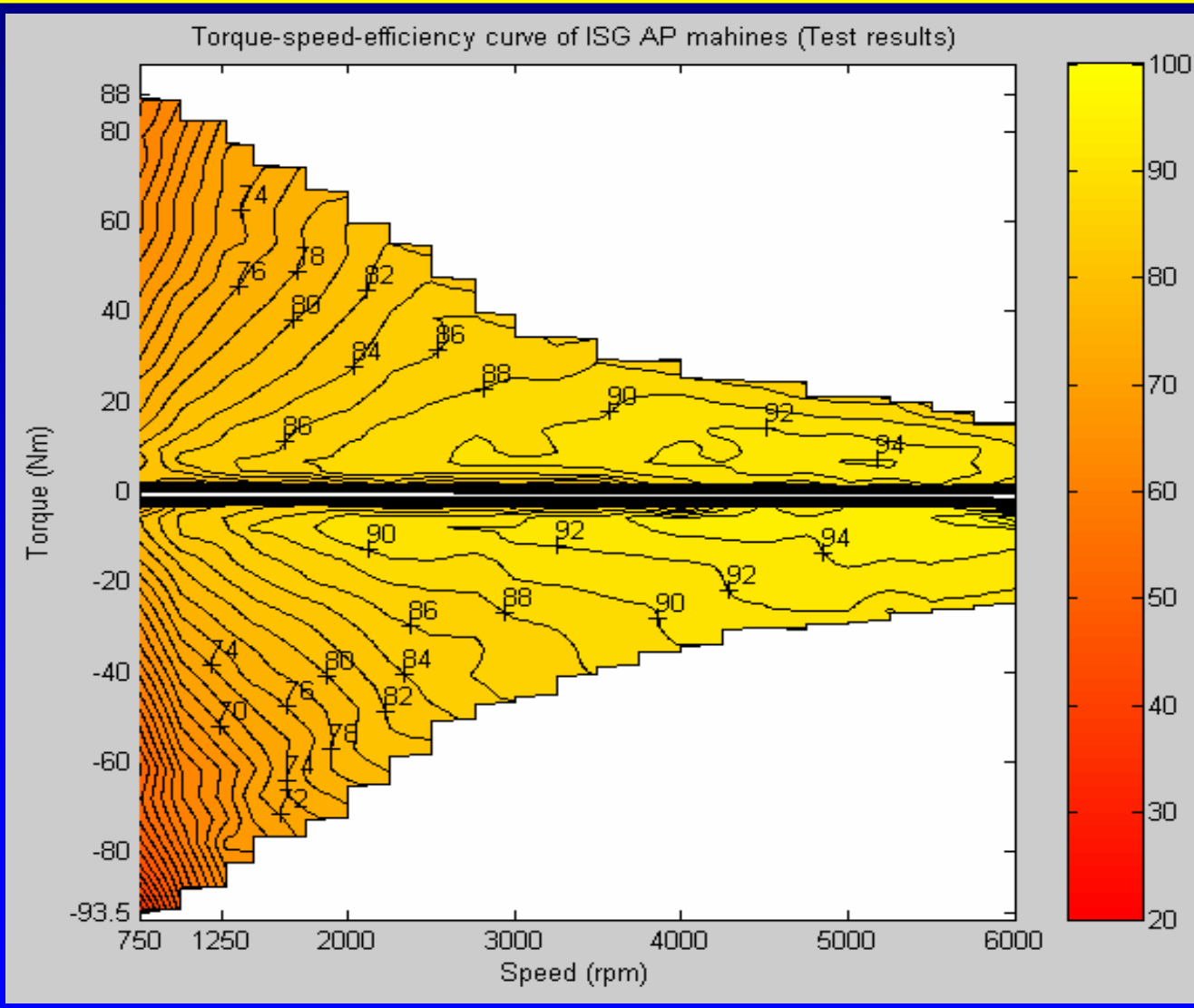

电机类型 Motor Type	预定指标 Target	FCV轿车主电机 Traction Motor in FCEV	纯电动主电机 Traction Motor in PEV	混合动力ISG电机 ISG Motor in HEV	混合动力轿车电机 Traction Motor in HEV	混合动力客车主电机 Traction Motor in Hybrid Bus
持续/峰值功率 continuous / peak power	5-180kW	24/65	15/45	10/15	14/28	80/180
重量比功率 Ratio of power to weight	1.2 kW/kg	1.358	1.087	0.94	0.94	0.448
系统最高效率 Maximum efficiency	> 90 %	93%	95%	91%	92%	92%

ISG电机性能

Similar products compare for ISG motor

批量装车的ISG电机高效区明显拓宽，效率80%高效区占到了80%以上，超过了50%的预期指标。

High efficiency field is distinctly boosted, and efficiency ratio over 80% is over 80%, which is wider than the requirement 50%



车用驱动电机系统的系列化产品

Products series of electric machine in EV

燃料电池汽车、纯电动汽车的驱动电机系统的产品

Products Used in FCEV and PEV:

Power range is from 30 ~ 180 kW: 30kW, 50kW, 65kW, 90kW, 120kW,

30kW

车用驱动电机系统的系列化产品

Products series of electric machine in EV

不同混合度的混合动力汽车用ISG电机的产品

Products Used in Hybrid Vehicle with Different Hybrid Mode :

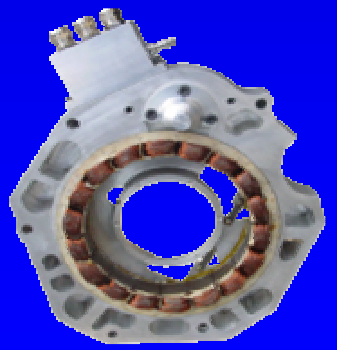
Power range is from 9 ~ 100 kW: 9kW, 15kW, 20kW, 30kW, 60kW, 00kW











车用驱动电机系统的系列化产品

Products series of electric machine in EV

小型电动轿车的驱动电机系统的产品样机

Products Used in Mini EV :

Power range is from 3 ~ 15kW: 3kW, 6kW, 10kW, 15kW






车用驱动电机系统的系列化产品

Products series of electric machine in EV

小型电动轿车的轮毂电机系统的产品样机

Products Used in Mini In-wheel EV :

Power range is from 3 ~ 15kW: 3kW, 5kW, 7.5kW, 15kW








2、面临的挑战、趋势和主要工作

Challenge, trends and main tasks

我国电驱动产业面临新的竞争压力
Competition of electric drive in China

- 国外重要的汽车系统供应商都在加大对电动汽车特别是混合动力汽车动力系统的投入，并且已开始进入中国，整合制造资源。

  Foreign vehicle system suppliers are boosting their investment on EV, especially on HEV. And they are integrating manufacture resources in china to entering into Chinese market.

- 经过863计划项目的支持与推动，我国电机系统供应商取得了长足的进步。在稀土永磁电机领域具有明显的竞争优势，然而产品的可靠性、耐久性和工艺水平需要进一步提升。更为重要的是，我们需要在动力系统层面形成自主的知识产权；在电力电子模块等关键零部件领域形成自主开发与供货能力。

  Under the support of national 863 project, native electric machine suppliers has increasing quickly, especially in PM electric machine. Whereas, reliability、duration and manufacture technology of e-motor is still to be improved. Further more, we need more patents independent on power electric, cultivating research and manufacture ability on primary parts, such as power module and ASIC etc.

车用驱动电机发展趋势

Development trends of electric machine for vehicle drive

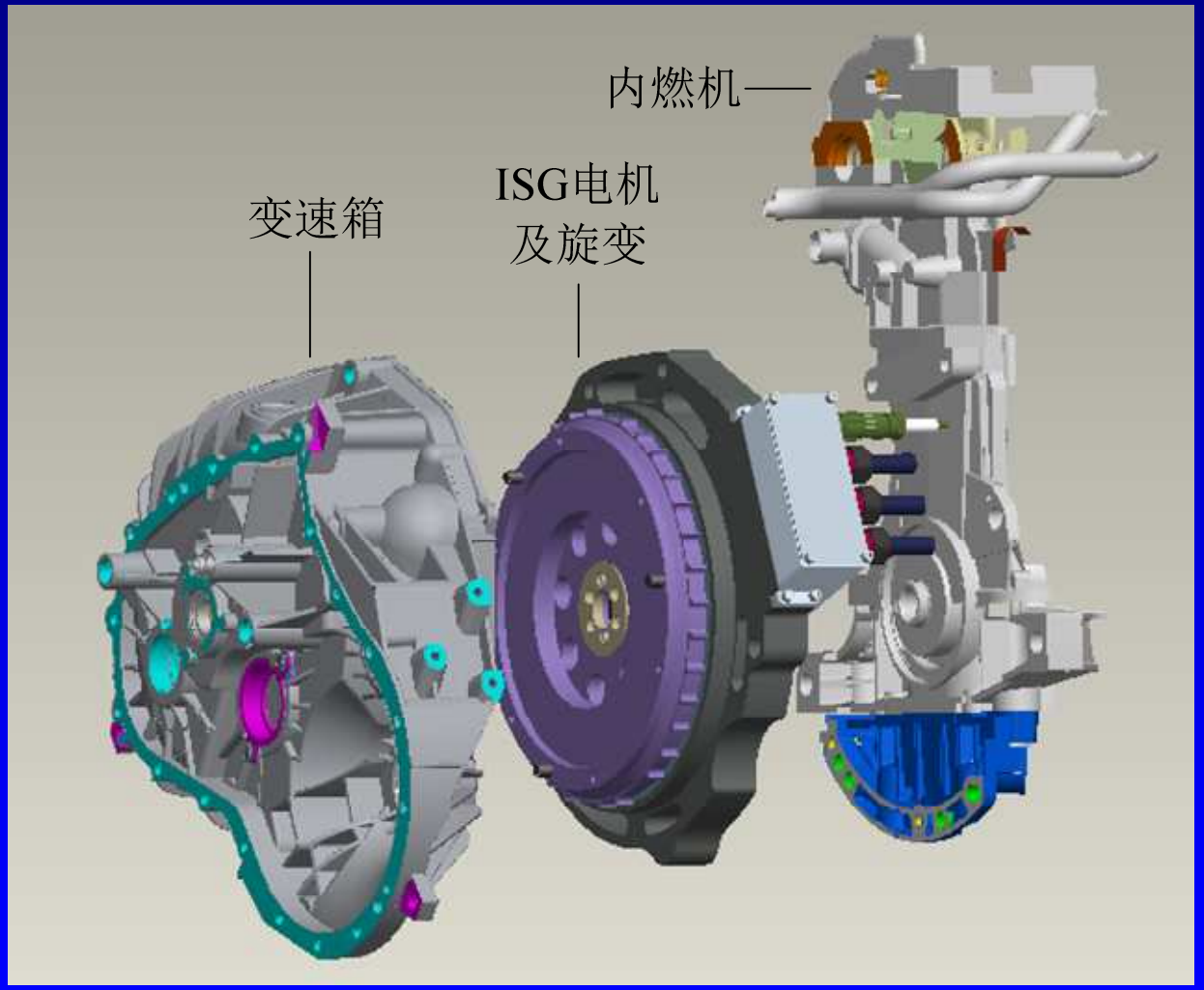
- 永磁化：永磁电机功率密度和转矩密度高、具有效率高、功率因数高、可靠性高和便于维护的优点。采用矢量控制的驱动控制系统，可使永磁电动机具有宽广的调速范围。
  PM motors takes advantages of high power density, high torque density, high efficiency, high power factor, high reliability and repairable etc. And it can be easily controlled in a wide speed range by vector control method.
- 数字化：数字化是电驱动技术发展的必然趋势。
  Digital control is the inevitable trend for electric drive technology.
- 集成化：集成化体现在两个方面：Integration including two aspects:
  电机方面：电机与发动机总成、电机与变速箱的总成
  Integration of e-motor and combustion engine, Integration of e-motor and transmission
  控制器方面：电力电子总成(功率器件、驱动、控制、传感器、电源等)
  Integration of power electric including power module, drive circuit, control circuit, sensor, power supply etc.

电机与发动机总成

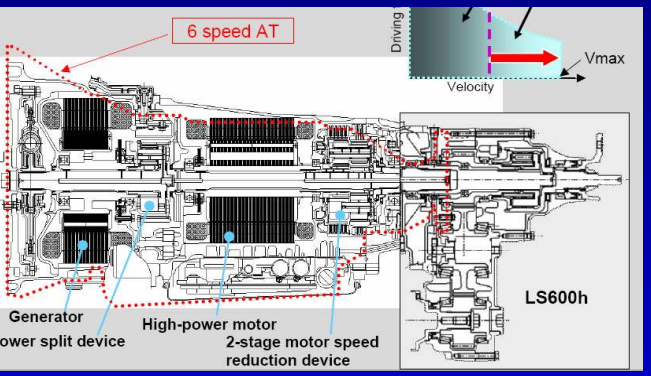
Integration of electric machine and engine

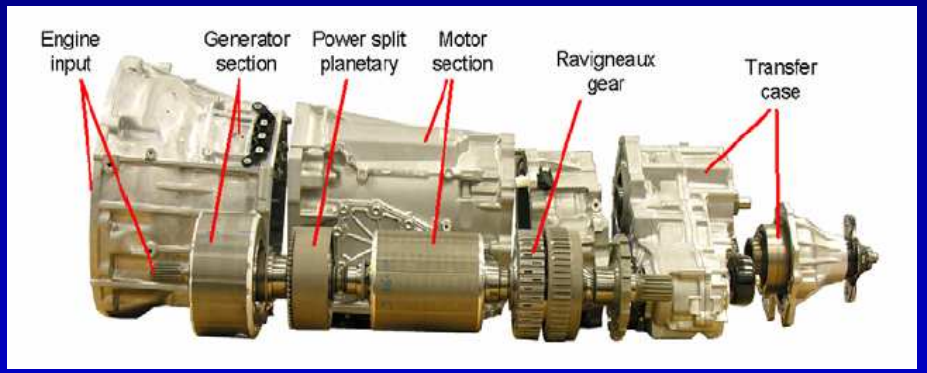
ISG电机—内燃机一体化结构

Integration structure of ISG and combustion engine



电机和减速器系统总成
Integration of electric machine and gearbox



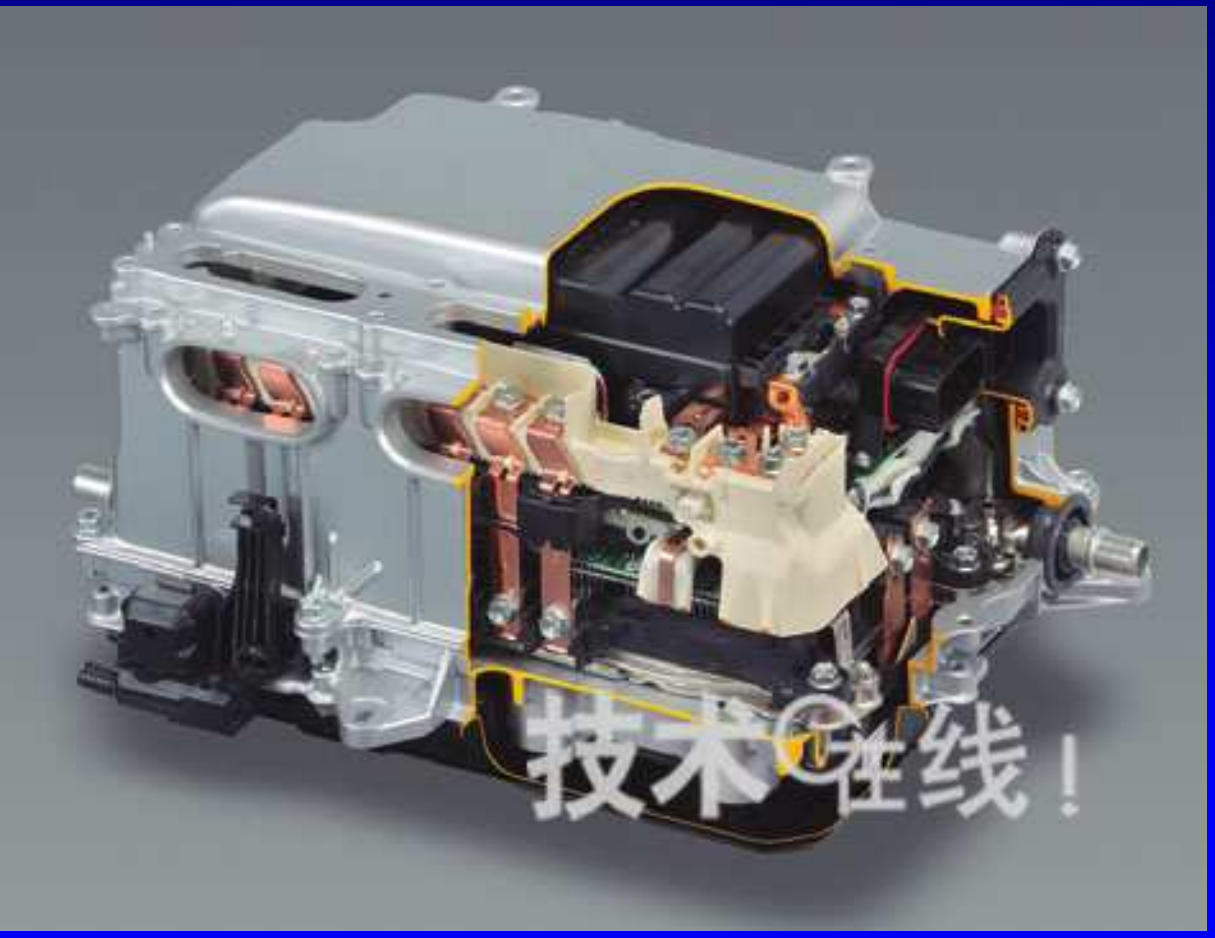


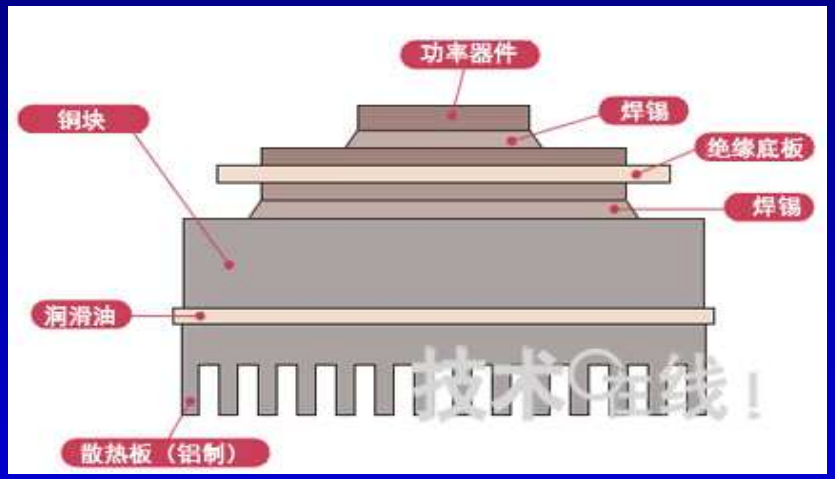
电机、减速器和离合器总成 Integration of electric machine 、gearbox and clutch

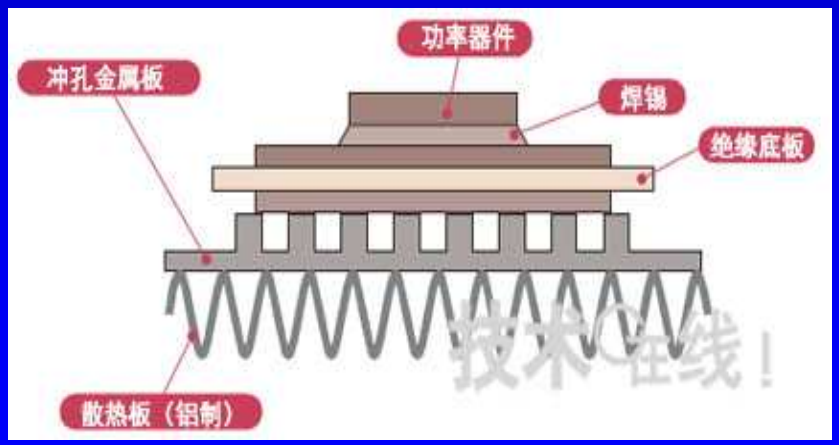
水冷机座、减速齿轮、制动盘一体化盘式车轮电机

Integration with in-wheel motor with water cooling frame、gear and brake disc

电力电子总成
Integration of power electric







PCU 、ECU、逆变器、升压转换器、DC-DC转换器全部内置

车用驱动电机下一步发展目标

Next targets of electric machine used in EV

- 掌握电机系统的优化设计技术、规模生产工艺和成本控制技术，掌握具有自主知识产权的关键技术，形成符合汽车工业标准的电机系统产品批量生产与供货能力；

  To master technology of optimization design, mass production and cost control, to gain more independent patents, to build up manufacture ability which according to the vehicle industry rules.

- 研发满足国内外整车需要的电机、驱动系统及一体化关键总成产品，在系统性能（特别是转矩密度、功率密度、效率和成本控制）、耐久性和系统应用方面达到国际同类产品的先进水平，部分企业和产品领先国际水平；

  To develop integrated product of electric machine, power electric, with system specifications being similar to those of foreign products, some products are to excess foreign leading level.

- 加强关键共性技术研究，解决深层次技术难点。建设电机系统及关键零部件共性技术研发和检测平台，发展电机系统关键元器件和关键材料。

  To research on primary technology, and to breakthrough key technology, to establish R&D platform and test platform for electric machine and key components, to boost ability on primary components and material of electric machine.

充分发挥我国车用驱动电机的产业优势

Take full advantage of electric machine industry in china

- 电机产业在中国有较好的工业基础，是人力资源相对密集型产业，且具有丰富的稀土资源，我国车用电机产业在全球资源条件下具有明显的比较优势，较易进入全球的分工体系，是具有中国特色道路的优势产业；

  There lies comparable basement on electric machine industry in china, and lies large quantity of personal resource and abundant PM resource. Thus, there is comparable stability foundation electric machine in china to enter into world market.

- 驱动电机的发展和整车的发展紧密相关，目前整车的发展有着明显的时代特征，车用电机应当密切关注，应立足中国，放眼世界，重点突破，跨越发展，尽早在我国形成主导设计和产业优势，形成国际竞争力。

  Development of electric machine is most related to development of vehicle. Today there is full of age's feature in vehicle development, thus electric machine industry should attend to the situation of vehicle, and to build up our leading design and industry advantage.

谢谢大家关注！

Thanks for your attention!