

特斯拉核心技术 电动车解决方案

Tesla's Core Tech: Solution for Electric Cars

——马斯克向外开源全部特斯拉专利

——Musk Opened Tesla's Patents



马斯克居然向外开源全部特斯拉专利，宣布分享专利技术，要推动电动车行业发展。这种现代版“钢铁侠”行为，着实震惊业界，让世界吃了一惊。

Tesla在2008-2013年期间所申请的核心知识产权大都是关于电池安全控制系统：电池冷却系统、安全系统、电荷平衡系统等。截止到2013年3月底，Tesla所申请的此类专利数量达142项，另有258项专利正在审核过程之中。

Tesla公布的相关专利(部分)如图一 “

文/ 雷辉煌 Text/Lei Huihuang

Musk opened all of Tesla's patents to the public. The purpose was to promote the development of electric vehicle industry. This really shocked the industry and the world.

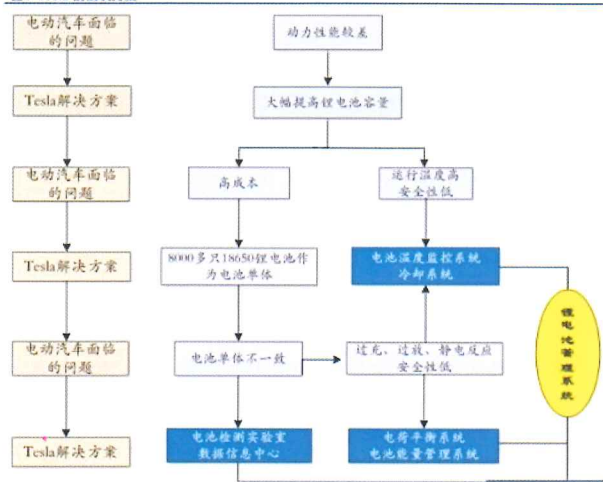
Tesla during 2008-2013 applied for core of intellectual property rights mainly in the battery safety control systems: battery cooling, security, and charge balance etc. By the end of March 2013, there were 142 patents in Tesla with the other 258 patents under approval. The relevant patents announced by Tesla are shown in figure 1.

Tesla's solution: small battery + BMS

Tesla electric car technical solution is small battery + BMS.

特斯拉解决方案：小电池+BMS

图：Tesla 的解决方案



Tesla的电动车的技术方案是小电池+BMS。

小电池采用松下三元材料(镍钴铝酸锂)比较成熟的18650型号(松下这种电池普遍用于笔记本之中)电池。

与现在电动车电池的主流趋势不同，Tesla是唯一一家直接采用18650型锂离子电池的公司，其他的电动车都用的是大电池。只不过Tesla需要8000多节18650型锂电池。普通家用笔记本电脑只要7-8节。Tesla采用小电池的理由有三：

一、工艺成熟。

过去15年多的时间里消费类产品所积累的先进技术能够应用于车载电池领域，消费类产品可在推动需求、降低成本的同时提高能源密度。而目前许多刚刚开发出来的大容量方型电池，仅仅属于实验型产品，并未有过量产经验，并不能达到成熟阶段。

松下是全球电池技术和规模最大的企业之一，产品缺陷最少，由于规模较大，也便于从中挑选出一致性好的电池。

二、性价比高。

Model S 85kWh车型电池动力系统总成本3万美元左右，单位储能成本400美元/kWh左右，是其他电动车储能成本的一半左右。18650电池的生产商众多，使得下游企业对上游厂商有较强的议价能力，电池的成本可以得到控制。而随着电子消费类用品的普及，18650价格也会继续下滑，特斯拉亦可从侧面受益。

三、可控安全。

每个电池单元的尺寸小，可每个单元的能量可控制在

Small battery is Panasonic's ternary material (nickel and cobalt plus aluminum acid lithium) battery. Its model is 18650 (Panasonic uses this battery widely in notebook).

Different from the mainstream trend of electric vehicle batteries at present, Tesla is the only one company directly using 18650 type lithium ion battery. The other electric vehicles use big batteries. But Tesla uses 8000 lithium batteries (which are the above type). Ordinary household laptops generally use 7-8 batteries. Tesla USES a small battery for the following three reasons:

1. The tech is mature.

The advanced tech accumulated in past 15 years can be used in car batteries, which can increase the market demand, reduce cost and increase the energy density. But now many of the newly developed large capacity type batteries only belong to the experimental products and still take a time to the mature stage.

Panasonic is one of the largest enterprises in the world in the field of battery. Due to the perfect quality and the large scale, these products from this company are consistent.

2. The high performance-cost ratio

The Model S 85 kWh model: Its battery power system totally costs about \$30000, unit energy storage costs about \$400 per kWh, is about half of that in the other electric car. There are many makers for 18650 type batteries, and the cost of the battery can be controlled. And with the popularity of electronic consumer products, 18650 type battery price will continue to fall. So, Tesla can also benefit from this.

3. Controllable and safe

The size of each cell is small, but each cell's energy can be controlled in a small range. When compared with the large size cells, even one cell fails, the impact from the failure can be reduced. But many of the small cells constitute the battery pack which increases the inconsistency between the cells, leading to the following issues: the imbalances in the cell temperature, charge, and voltage; cell overcharge or over-discharge and electrostatic interactions. These issues will reduce the battery life and safety.

Core technology: battery management system

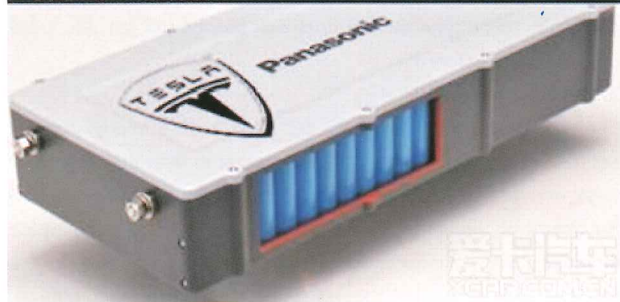
Battery management system is the core tech of Tesla. Elon Musk is majored in physics, and hires about 1000 engineers in Silicon Valley. This is the root cause why Tesla is leading in technology.



较小的范围，与使用大尺寸电池单元时相比，即使电池组的某个单元发生故障，也能降低故障带来的影响。

但是将众多小电池单体组成电池组，将大幅增加电池单体之间的不一致性，导致单体温度、电荷、电压出现不平衡现象，引起个别电池过充、过放并产生静电反应，从而降低电池组寿命以及安全性。

核心技术：电池管理系统



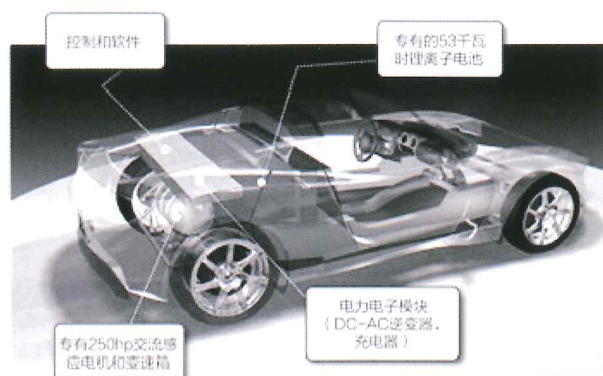
电池管理系统是Tesla的核心技术。Elon musk本身是学物理出身，又在硅谷招聘了上百名工程师，这是它技术领先的根本原因。

Tesla建立电池检测实验室、数据信息中心对18650对其温度进行智能监控。

一、电池检测实验室：从源头解决单体电池的一致性

因标准18650电池单体容量较小(约10.4wh)，Tesla Model S 85kWh版电动电车就需要8000多颗电池单体。如此众多的电池单体所组成电池组，会大幅增加单体之间的不一致性，容易导致个别单体过充、过放并产生静电反应从而降低电池组寿命并产生安全隐患，从而对单体的一致性检测提出极高的要求。

Tesla拥有一个独立的锂电池监测实验室并依据锂电池



Tesla has built a battery testing laboratory and a data information center to smartly monitor the temp of 18650 battery.

1. Battery testing laboratory: to solve the issue on the battery consistency For the standard capacity of 18650 cell is small (about 10.4 wh). Tesla Model S 85 KWH edition electric car requires more than 8000 cells. Such number of cells leads to the issue of the inconsistency. Other issues include the overcharge, overdischarge and electrostatic interaction so forth. Thus, there are high requirements on the consistency of the cells.

Tesla has an independent laboratory and a data center for the batteries. The two facilities do the relevant performance tests and consistency screening for Sanyo 18650 batteries. The main indicators include: cell capacity, energy storage time, power output, voltage lower or upper limit and etc. The batteries with better consistency and safety can be used as backup ones so as to fundamentally guarantee the stability and durability of the power transmission in the battery pack.

2. Charge balance system: to effectively ruled out the failed cells (18650 type) Each lithium cell has voltage upper limit and lower limit. During this range, the battery can work normally. If this range is exceeded, its chemical properties will substantially change. In this case, we must immediately stop discharge or charge, otherwise there will be an irreversible damage to the battery and a significant increase in the rate of self-discharge of the battery, and electrostatic reaction even resulting in an explosion.

Many of cells will greatly increase their inconsistency leading to the difference in the safety range of the battery voltages and a substantial decrease in safety.

Tesla independently researches and develops the charge balancing system, which can effectively detect the failed cell and ensure the safety of the vehicle performance. Tesla battery tail is configured with a printed circuit board which has a variety of power switches. One end of each power switch is linked to a certain18650 battery, while the other end connects a medium-sized charge collector (i.e. cell charge monitor).

When a battery in a battery pack is different from the other batteries in power due to overcharge, over-discharge, and high temperature. The charge collector is to transfer the energy and prevent it from exceeding the safe range. When the battery really makes a

单体化学性能、形状系数建立了一个完备的数据信息中心，通过这个实验室以及数据中心将电池供应商Sanyo所提供的18650电池进行严格的性能测试以及一致性筛选，主要关注指标包括：单体容量大小，储能持久性、功率输出大小、电压上下限等。其中一致性、安全性较好的电池作为电池组备用电池，从而在根本上保证电池组功率传导的稳定性以及持久性。

二、电荷平衡系统：有效排除18650有故障单体电池

每个锂电池单体都有一个电压上限和下限，电池在此范围内可正常工作，但一旦单体电压接近这一限值其化学性能将发生突变，必须立即停止放电或充电，否则电池将会受到不可逆的损坏，将会大幅增加电池的自放电率、产生静电反应进而引起爆炸。

众多电池单体所组成的电池组大大增加了单体之间的一致性，导致电池电压的安全范围各不相同，安全性大幅降低。

为此Tesla自主研发单体电荷平衡系统，可有效排除故障单体，保证整车安全性能。Tesla电池组尾部安装有印刷电路板，内置众多电源开关，每个电源开关一端连接某个18650电池单体，另一端连接一个中型的集电器(单体电荷监控器)。

当电池组中某一电池因过充、过放、温度过高导致电量与其他电池不同时，集电器就会将能量在电池之间进行相互转移，防止其电压超过安全范围而产生异变。而当该电池真的产生异变时，电子集成器将控制电路板上相对应的电源开关弹开，从而将此电池单体隔离，避免产生静电反应而引起爆炸。

三、电池温度管理系统：提升整车安全性能

Tesla高达60kWh、85kWh的电池组容量使其运行过程中将会释放更多的热量，从而加大了电池组温度过高引起爆炸的概率，这是Tesla电池管理系统解决的最为核心的问题之一。

negative change, then this collector will eject the power switch out in the PCB, so as to isolate the cell and avoid the explosion caused by the eletrostatic reaction.

3. Battery temperature management system: to improve vehicle safety
In Tesla, the battery pack up to 60 and 85 KWH capacity makes its operation process to release more heat and thus increase the probability of an explosion caused by the battery temperature being too high. This is a core question solved by Tesla battery management system.

Tesla electric vehicle related tech system



Electric cars are a complete system project. In addition to the core technology, there are other relevant peripheral tech. The main three techniques are as follows:

Vehicle energy control system: timely performance control

Tesla uses the three-phase induction motor with optimal winding linearity, which can minimize resistance and energy loss. If the electrical energy use efficiency is low, then this will offset the power performance advantage of the high capacity battery pack. There is a need to use the intelligent power management software to digitalize the current data and convert the power into the kinetic energy and improve the utilization efficiency of energy.

Gearbox is a single-pole variable speed system, and can will optimally match the torque with the vehicular speed. When compared with the conventional gasoline gearbox, it has better accelerated motion performance. Tesla electric car has a relatively





Tesla电动车相关技术系统

电动车是一个完整的系统工程，除了核心技术，还需要相关的周边技术与之配套。其主要的有下列三项：

整车机体的能量控制系统——适时性能管控

Tesla电动车所用电动机为自主研发的三相感应电机，拥有最优化的缠绕线性，能够最大限度的减少阻力以及能量损耗。电机能量使用效率低，降低了高容量电池组所带来的动力性能优势，需要强大的动力系统配备智能化的能量管理软件将各个电池单体的电流数字化并将电池组电能有效转换为电车动能，提高能量利用效率。

变速箱为单极变速系统，能够将交流感应电机所产生的扭矩与车速进行最优化的匹配，相比传统的汽油变速箱具有更好的加速运动特性。Tesla电动车上安装有较为完善的软、硬件系统，包括转动变频器、数字信号处理系统以及充电系统，用来控制电动机的扭矩以及电池组的能量传输过程，是整个电动车机体的能量控制系统。

通过一个高性能的数字信号处理器可以将电车制动、刹车、加速、减速等要求转变为数字信号，从而控制转动变频器将电池组的直流电与交流电相互转换以带动三相感应电动机提供相应的电车动力，同样通过转动变频器可以将再生制动系统所产生的交流电转换为直流电以完成充放电过程。

二、电池组温度检测系统——智能温度监测

perfect system of software and hardware, including rotation frequency variator, digital signal processing system, and charging system to control the motor torque and energy transmission. It is an energy controller in the entire electric car.

Through a high performance digital signal processor, we can convert the requirements about car braking, acceleration and deceleration into digital signals so as to control the conversion between AC and DC currents. Similarly, through the rotation frequency variator, we can control the conversion of the AC current into the DC current in the braking system so as to complete the charge and discharge process.

2. Battery temperature detection system – intelligent temperature monitoring

Electric car safety is mainly manifested in the control of battery temperature and current; especially in the large capacity battery module, when the battery is in overcharge and over-discharge, collision and run, the excessive heat will cause the battery temperature to be too high and explode.

In Tesla car battery pack, one cell is connected to a thermistor and a series of optical fiber, at the same time, the thermal resistor is connected to the battery monitor. The optical fiber is linked to the photosensitive sensor.

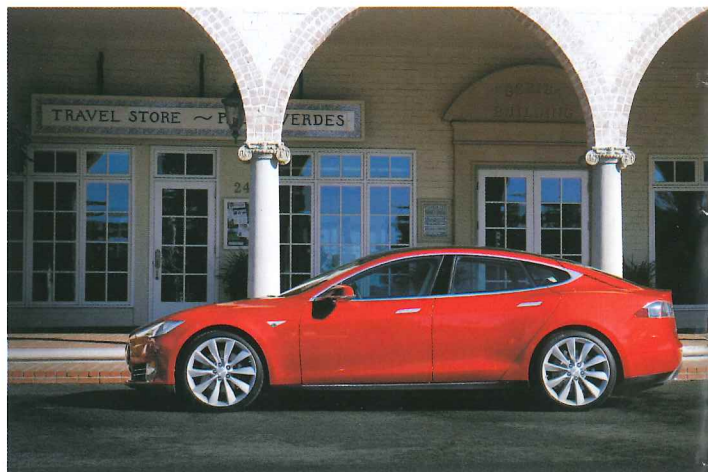
When the cell temperature exceeds the safety range, then the thermistor will produce and send an electrical signal to the battery monitor in order to start the battery condensing system to assure the safety of the battery performance. When the battery's thermal runaway phenomenon occurs, this will affect the transmission of the light beam in the fiber optic, thus stimulating the photosensitive sensor to issue a signal for thermal adjustment.

When the electric car has an intense collision, then the energy transmission path between the battery pack and the motor will be blocked at once. The outer layer of the battery pack will protect it from the collision impact so as to avoid violent explosion.

3. Battery liquid condensation system: real-time temperature control

IN this system developed by Tesla, the first layer is a cooling loop designed for cooling the battery pack. The battery loop links the battery pack and the cooling pump. In the loop is filled with coolant. It extends to multiple cooling pipes so as to cover each cell.

First-layer cooling loop will link the heat control system, ventilation equipment, and other heat radiators to the battery thermal management system, so as to ensure each cell's temperature below a safe value and ensure the heat dissipation and safety performance.



电动电车安全性能主要体现在对电池组温度以及电流的控制上，尤其对于大容量的电池模组，当电池组过充、过放、碰撞以及运行过程中电池过度发热都会引发电池组温度过高而引发爆炸。

Tesla电车电池组中的每一个电池单体都连接着一个热敏电阻以及一系列的光导纤维，同时将热敏电阻连接到电池监控器，将光导纤维连接到光敏感应器。

当某个电池单体温度超过安全标准时，热敏电阻将产生一个电信号传达至电池监控器以便启动电池冷凝系统保证电池安全性能。当电池发生热逃逸等现象时，将影响光导纤维中光束的传输，进而刺激光敏感应器发出相应信号进行热度调节。

而当电车发生剧烈碰撞时，电池组与电机的能量传输路径将被立即阻断，电池组外保护层将保护电池组免受碰撞影响，从而避免发生剧烈爆炸。

三、电池组液体冷凝系统——实时温度控制

Tesla自主研发的机体液体冷凝系统为双模式冷却系统，其中第一层冷却回路专门为电池组降温，电池回路将电池组与冷却泵相连接，回路中充满了冷却剂，且延伸多个冷却管覆盖至每个电池单体。

第一层冷却回路将控热系统，通风设备以及其他散热装置与电池组热量管理系统连接起来，从而保证每个电池单体温度低于其安全值以下，保证其散热性以及安全性能。

第二层冷却回路包括第二冷却储液罐并与至少一个转动部件进行热交换，并立于第一个冷却回路，保证电池组冷却系统的独立性。

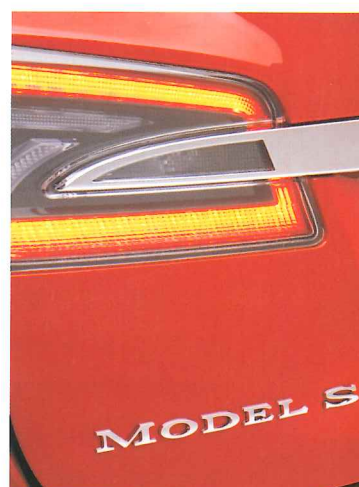
Tesla公司承诺为Tesla Model S电池组提供8年或是10万英里的质量保证，其电车其他部件提供4年或是5万英里的质量保证。最近更是推出一项免费服务计划，特斯拉将为因保养不善而遭到损耗的电池组提供保修，并将为客户免费更换相同质量或性能更好的电池，其电池组质量可见一斑。

Tesla的成功可以说是系统专利的成功！

Second-layer cooling loop includes the condition where the second cooling liquid storage tank stands in the first cooling loop and exchanges heat with at least one rotating component so as to ensure the independence of the battery cooling system.

Tesla promises that Tesla Model S battery provides the quality guarantee of 8 years or 100000 miles and other parts of 4 years or 50000 miles. Especially, it recently has launched a free service plan: Tesla will offer the warranty for the battery pack damaged due to poor maintenance, and freely provide the battery which is the same quality or better in quality.

Tesla's success is the success of the patent system.



电动汽车的动力总成，尽管电动汽车已经面世多年，普通消费者并不太清楚。我们所说的电动汽车是纯电力驱动的纯电动车。不包括燃料电池车和插电式混合动力车。纯电动车动力总成主要包括电池组、控制器及电机等三大部件。

电池组是动力源泉

其实早在100年前就有电动车这个品种，只不过那时候电动车的电池即笨重，又低效，并且容量很小，更不用提电池管理技术和安全技术了。

经过几十年的发展，电动车的热门能量储存系统由铅酸电池变为了锂电池。特斯拉在2008年推出的Roadster车型中采用了将近7000颗锂电池。每个车企都认为他们的锂电池性能是最优秀的，但实际上，他们采用的都是类似的可充电锂离子电池。

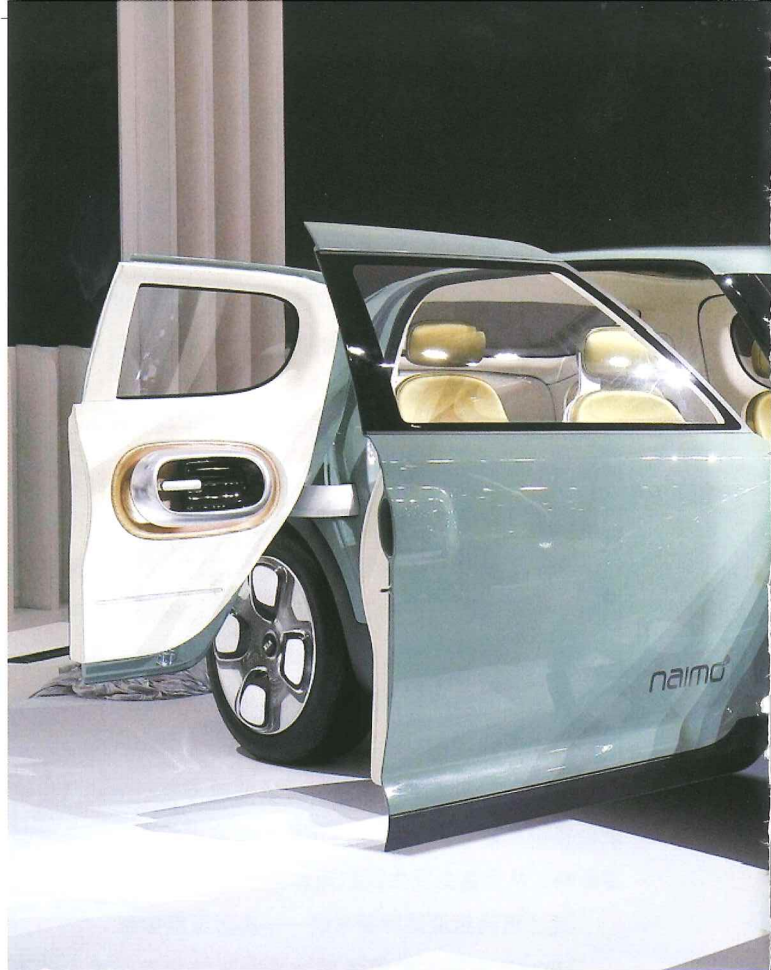
电池组所需充满电的时间由电池组容量、充电装置功率、充电电流决定。所有的电动车都拥有制动能量回收功能，能够在车辆减速过程中将热能转化为电能反哺至电池组。不过，靠该途径获得的能量对于电动车所需的驱动能量来说微乎其微，一些企业吹嘘的可以通过能量回收的方式让电动车变为“永动机”的说法完全不切实际。

在充电方面，虽然可以依靠家用电网插口进行供给，不过这是效率最低的方法。即便是三菱i-MiEV中的16千瓦时电池组都需要花费20小时才能充满，而特斯拉最高配Model S的85千瓦时电池组则需要数日。

当然，用户可以花费额外的几百美元在家中配备电动车供应设备(Electric Vehicle Supply Equipment, EVSE)，令充电效率高一些。

速度最快的充电方式就是共用充电站的直流快充，其电压一般能达到480伏，当然特斯拉的超级充电站更高，能够在20分钟内充满80%的电量。

如今的电动车电池都内置电池管理系统BMS，由软件对其



纯电动车动

The Secret of The Pure

Electric car powertrain is unclear in the mind from the average consumers, although electric cars has been available for many years. What we mean by the electric car is a pure electric vehicle. It does not include fuel cell vehicles and plug-in hybrids. Pure electric vehicle powertrain mainly includes three parts: battery, controller and motor.

Battery is the power source

In fact, as early as 100 years ago, electric cars emerged. But at that time, the battery used in the electric vehicle was bulky, inefficient, and small in capacity, not to mention the battery management technology and safety technology.

After decades of development, the lead-acid battery is replaced





by the lithium battery. Tesla in 2008 adopted nearly 7000 lithium batteries in its Roadster. Every car company thinks that their lithium battery performance is the best, but in fact, they are all similar rechargeable lithium ion batteries.

The charge time is determined by battery capacity, charging unit power, charging current and so forth. All electric cars have a braking energy recovery function, that is, they can convert the heat into the electric energy stored in the battery in the vehicle deceleration process. However, this energy obtained by this way is very low. It is false that some enterprises boast that they can let the electric car become a perpetual motion machine through the such energy recovery.

In terms of charging, the household power supply socket is available. But this is one of the least efficient ways. Even in the mitsubishi i-miev, 16 KWH battery takes 20 hours to be fully charged. In Tesla's Model S, the 85 KWH battery requires a few days for a full charge.

Of course, for the user, the EVSE (Electric Vehicle Equipment) equipped at home at a high cost has its charging efficiency being higher.

The fastest way in charging is the DC fast charging by sharing a charging station. Its voltage is usually 480V. Of course, Tesla's super charging station is better, which only take 20 minutes for a full charge.

Now the electric vehicle has a built-in BMS (battery management system). The software is used to control the charge and discharge. Battery management system is mainly to prevent excessive battery discharge and charge. And the purpose is to extend the service life of the battery as much as possible.

Actually, even if the battery power is "empty", it still can provide a certain amount of current, but this will seriously affect its service life. In some ways, like the human, the battery can better work under appropriate temperature. In extremely cold and hot conditions, of course, they can also work, but the mileage will be significantly lower than normal. Engineers in order to solve this problem, can add an active temperature control system in battery, usually adopting the coolant. But some automakers still confidently are without any temperature control system, e.g.2015 Volkswagen passat e - Golf electric vehicle. According to VW, the battery in this car has adopted more appropriate electrochemical materials, virtually no spontaneous tendency to heat, thus, there is no need for the temperature control system.

The controller is the command center

Controller is like an electric command center. Simply speaking, a

力总成的秘密

Electric Vehicle Powertrain

文 / 阿茵 Text / A Yin

充放电进行控制。电池管理系统主要防止电池过度放电，或电量过分充盈，目的是为了尽可能地延长电池的使用寿命。

其实，即便电池能量“空”了，其仍然能够提供一定量的电流，但这样会严重影响其使用寿命。

在某些方面，电池与人类一样——它们在适宜的温度下工作表现更为出色。当然，在极冷与极热的温度条件下它们也能工作，只不过其可支持的续航里程要明显低于正常水平。工程师们为了解决这样的问题，会在电池中加入主动温控系统，通常采用液冷的方式。而一些车企仍然很





自信地不采用温控系统，例如2015款大众e-Golf电动车。据大众描述，该车的电池中采用了更合适的电化学材料，几乎不存在自发热倾向，因此无需温控系统。

控制器是指挥中心

控制器犹如电动车的指挥中心，简单说来，控制器就是将电池能量与驱动车轮的电机联系起来的桥梁。当司机踩下加速踏板的过程就是对控制器进行操作的过程，控制器的角色就相当于家中可调光灯中的变阻器。

在车中，与加速踏板连接，它能够使电流输出功率在某一范围内进行变化。电池供向电机的电流由控制器进行变化调控。

最新的电动车采用高效、高功率的交流发电机，控制器则负责将电池中的直流电转化为交流电。

电机是能量转换器

电动车中负责驱动车轮的电机还被称为牵引电机。交流感应电机和交流永磁电机是目前使用最广泛的电机种类，它们拥有高扭矩、运行稳定、重量轻的特点。



controller is to link the battery power and the motor in the drive wheel. When the driver steps on the pedal, the controller will be operated. The controller is equivalent to the adjustable resistor in the lamp at home.

In the car, it is connected to the pedal and it can make the current output power to change in a range. The current from the battery to the motor is controlled by the controller.

The latest electric vehicles are with high efficiency and high power ac generators. The controller is responsible for the conversion of the direct current in the battery into alternating current.

The motor is an energy converter

The motor responsible for driving the wheel is also referred to as the traction motor in the electric car. Ac induction motor and ac permanent magnet motor are currently the most widely used types. They have the following characteristics: high torque, stable operation and light weight.

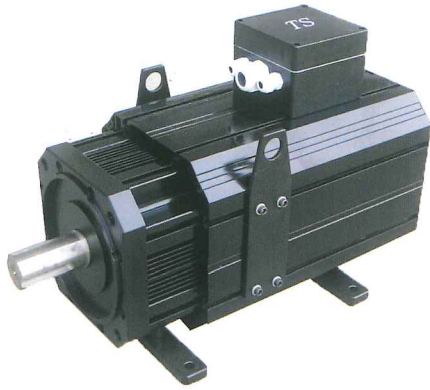
In the motor, the stator uses the alternating current from the power system to generate the magnetic field. The rotor inside the stator is responsible for converting electrical energy into mechanical energy. In addition to playing the role as power transmission, the motor will be able to recharge the battery. At this time, the motor is called the "generator". When the electric vehicle decelerates, then the braking energy recovery system is through the motor to send the electric power back to the battery.

An electric car can carry one or more motors. The others adopt the wheel hub motor, that is, the motor is installed directly on the wheel. But the wheel hub motor still has a problem, i.e. demagnetization problem which is still not fully resolved. Now, it is rarely used in medium and large electric vehicles.

Motor driver, when compared to the traditional internal combustion engine, has the advantage that its energy utilization rate is higher, and that it is able to achieve maximum torque from the start. On the vehicle accelerating performance, it is far beyond the internal combustion engine.

Powertrain structure is simple

For pure electric vehicles, if the transmission ratio gear reducer is used, that is, the transmission device is canceled, then the vehicle's acceleration time and maximum speed performance are often restricted with each other. Thus, for the pursuit of good vehicle acceleration and high top speed in pure pure electric cars, electric cars, especially the pure electric sports car, under the limitations of motor weight and cost increases, the transmission device can be installed, which can not only improve the vehicle top speed, but also shorten the vehicle acceleration time. However, like the family cars whose performance is not comparable to the



电机中的定子利用动力系统传递来的交流电生成磁场，定子内部的转子则负责将电能转化为机械能输出。

除了担任动力传递的角色之外，电机还能够为电池进行反向充电，此时电机被称为“发电机”。在电动车减速时，制动能量回收系统则是通过电机将电能传回给电池。

一辆电动车中可以搭载一个或多个电机，有些则采用轮毂电机的方式，将电机直接安装在车轮内部。但轮毂电机退磁问题还没有完全解决，目前在中型及大型电动车上鲜有采用。

电机驱动相比传统内燃机驱动的优势在于，其能量利用率更高，并且能够从一开始就达到最大扭矩，在车辆加速性能上远超前于内燃机。

动力总成结构简单

对于纯电动汽车而言，如果采用定传动比减速器，即通常所说的取消变速器，车辆的加速时间和最高车速性能往往相互制约。因此，对于追求车辆加速性能好、最高车速高的高性能纯电动汽车尤其是纯电动跑车，在电机重量和成本增加空间受限情况下，可以考虑加装变速器，从而既提高车辆最高车速，又缩短车辆加速时间。然而，正如家用轿车的性能不能按照跑车的标准要求，纯电动跑车与日常出行使用的纯电动汽车对性能的要求也不尽相同。实际上，通过合理设计电机特性曲线，匹配减速器减速比，大部分纯电动汽车最高车速也可以设计在时速150公里以上，基本上能够满足市场需求。因此，从性能角度来看，纯电动车没有必要加装变速器。

特斯拉Model S则以9.73:1的固定减速比实现130英里/时的最高时速。当然，相反的例子也有。保时捷Panamera S E-Hybrid就能在纯电动模式下配合8速手动变速箱行驶。

不管怎样，电动车无论在性能、后期保养、维修成本上相比传统内燃机都更有优势。

that in the sports car, the pure electric car for daily need is different from the pure electric sports car in the relevant requirement. In fact, by the reasonable design of motor characteristic curve, the majority of pure electric cars have a top speed more than 150 kilometers per hour, so basically meeting the demand of the market. Therefore, from the performance perspective, the pure electric vehicle is not necessary to add the transmission device.

In the tesla Model S, the fixed deceleration ratio is 9.73:1, which can lead to the max speed of 130 miles per hour. Of course, the opposite examples exist. Porsche eve S E – Hybrid Car uses the 8–level manual gearbox in the pure electric mode.

Anyway, electric cars are better than traditional internal combustion engine type cars in performance, maintenance and repair cost.

