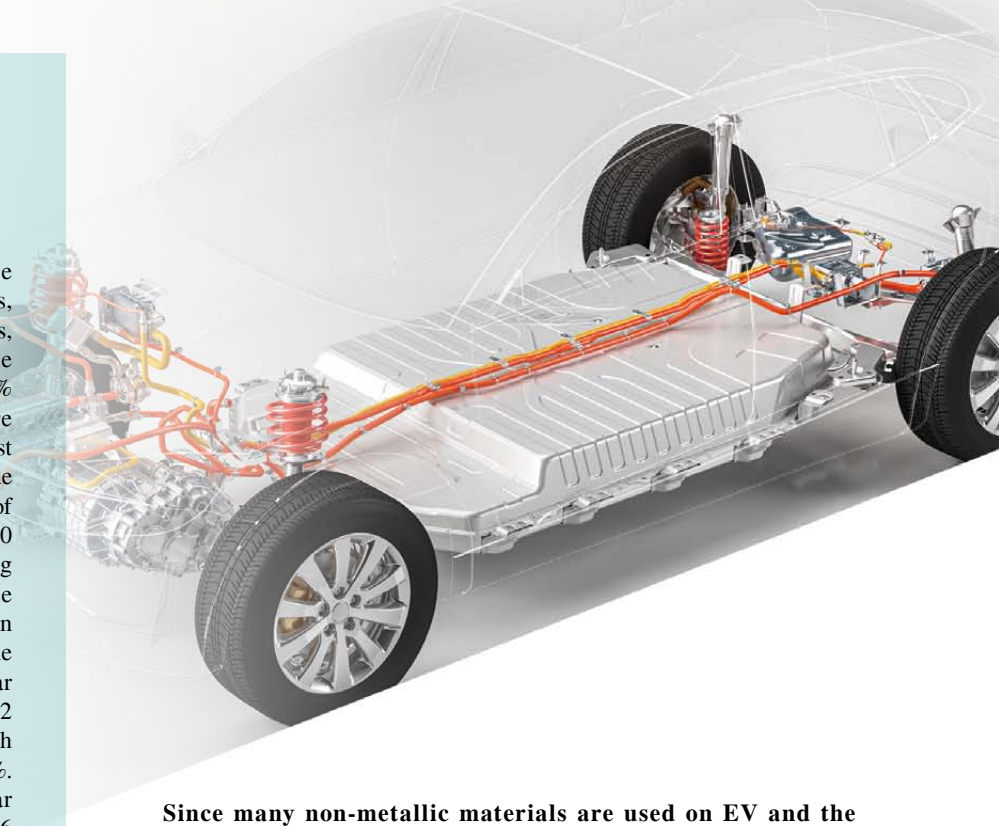
# The Market Demand and Outlook for Automotive Fasteners Used on New Energy Powered Vehicles

*by Chin Feng & Hsien Ming Chang*



## The Market Demand for Automotive Fasteners Used on New Energy Powered Vehicles

There are many types of automotive fasteners on the market, such as bolts, studs, screws, washers, retaining rings, pins, rivets, assembly parts, connecting parts, etc. The demand for automotive fasteners is around 23% of the total amount demanded in the entire fastener industry, which represents the highest market share in the industry. According to the latest statistics released by China Association of Automobile Manufacturers (CAAM), in 2020 the profit margin of Chinese car manufacturing industry showed a slight increase from the previous year's slump, but the increase margin was a little bit slowed down compared to the period from Jan. through Nov. In 2020, the car production and sales of China reached 2.522 million units and 2.531 million units, with the same period ratios being -2% and -1.9%. The cumulative profit margin of Chinese car manufacturing amounted to CNY 509.36 billion, up 4.0% from the previous year's same period.

In recent years, the EV market has been continuously growing, which is significantly revealed on the stronger support of the Chinese Government to the EV industry and the further investments of car manufacturers in their EV business. Such a growing trend is estimated to continue in the following 10 years. With the growing acceptance and application of EV on the market, the demand for these types of fasteners will definitely grow bigger. As a result, the safety of these products used for fastening EV batteries whose power and performance are also becoming more efficient has also become a serious concern in the industry.

**Since many non-metallic materials are used on EV and the requirements for their temperature resistance and safety are higher, the correct use and fastening of fasteners have thus become a critical part in EV assembly.** The annual production and sales of new energy powered vehicles reached a new high in history as well. In addition, with years of dedication to the development of the new energy powered vehicles supply chain, more mature industrial sectors, more new energy powered vehicles for selection, and improved environment for driving them, these cars have been gradually accepted by consumers. In 2020, the production and sales of new energy powered vehicles in China reached 1.366 millions units and 1.367 million units, which were up 7.5% and 10.9% respectively from the same period in the previous year.

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Of the new energy powered vehicles in China, pure electric vehicles (EV) reached 1.105 million units of production and 1.105 million units of sales (up 5.4% and 11.6% respectively from the previous year's same period); plug-in hybrid electric vehicles (PHEV) reached 0.26 million units of production and 0.251 million of units of sales (up 18.5% and 8.4% respectively from the previous year's same period); fuel cell electric vehicles (FCEV or FCV) reached 1,000 units of production and 1,000 units of sales (down 57.5% and 56.8% from the previous year's same period).

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According to CAAM, the sales of new energy powered vehicles in 2020 represented 5.4% of the total car sales in China, up 0.7% from 2019's 4.7%. In 2020 the total car sales of the top 10 car manufacturers in China reached 22.644 million units, down 2.3% from the previous year's same period and representing 89.5% of the total sales in China (down 0.4% from the previous year's period).

Of the top 10 car manufacturers in China, Saic Motor remains the largest group. In 2020 its sales reached 5.534 million units, down 11.5% from 2019. FAW Group, Changan Automobile, Great Wall Motors, and Brilliance Auto Group of the top 10 all appeared growing momentum, while the others appeared a decline in sales.

Tesla did bring pressure to local Chinese EV brands after it officially entered the Chinese market, so traditional car manufacturers such as NIO, Li Auto, XPeng, Volkswagen, Toyota, etc. were also forced to accelerate their development in new energy powered vehicles. The premium effect of Tesla as well as its strategy to gain more market share via price reduction will definitely take some market share of other competitors away, as the Model 3 at the cost of CNY 0.25 million and the Model Y at the cost of CNY 0.30 million remain attractive to consumers. As a result, most Chinese EV brands will face a certain degree of pressure, especially those at higher prices, most of which may be later forced to reduce their prices to below CNY 0.20 million.

The price reduction of Model Y will directly impact the sales of traditional luxury car brands. After the price reduction, the price competition among Tesla Model Y, Audi Q5, M. Benz GLC, BMW X3 may appear a significant change. As the price of Tesla Model Y is comparatively competitive, it may attract more luxury car consumers to buy it. In addition to the impact on BMW, Audi, and many other luxury brands, it may also cause impacts on other new energy powered vehicle brands, especially NIO and XPeng.

NIO EC6 and Tesla Model Y are both defined as medium sized SUV. In terms of price, the sales price of NIO EC6 after receiving subsidies lands at CNY 0.368 million-0.526 million, and the sales price of Model Y lands at CNY 0.3399 million-0.3699 million, showing that Model Y is more competitive than EC6 when it comes to price.

There are more than 100 above-the-scale automotive fastener manufacturers in China, which can be classified into "large-scale fastener companies specialized in automotive fasteners manufacturing" and "companies specialized in non-standard automotive fasteners manufacturing." Compared with other similar foreign manufacturers, these companies in China have not been able to reach larger manufacturing capacity yet and their high-end fastener supply to new energy powered vehicles is not sufficient, either. With the fast market development in the future, the demand for high-end fasteners will continue to rise and the development of high-end products will become a major trend.

## The Technology Development of Automotive Fasteners for New Energy Powered Vehicle

### Application of Lightweight Materials

More and more Mg-Al alloy or other lightweight materials are used in design and manufacturing of new energy powered vehicles; however, as the significant potential difference between steel and Mg-Al alloy will result in serious electrolytic corrosion and the significant difference in the coefficient of thermal expansion between steel and Mg-Al alloy will result in a serious change in preload, making joints come loose, it is suggested that aluminum alloy fasteners with high tensile strength be used to deal with these issues.

Given the weight reduction of vehicles, a lot of high-strength steel plates are used in car manufacturing and aluminum alloy plates are also used in some design to further reduce the total weight of vehicles. The thin metallic plates represent a lot of portion in car production and assembly, such as welding of body in white, joint of cars. Using fasteners to fasten metallic plates is a major way (in addition to welding) in car manufacturing and the use of aluminum alloy plates at non-bearing areas instead of using steel plates is mainly due to its light weight. However, aluminum alloy features very poor weldability, so it is usually fastened with fasteners. For example, dual screws and weld nuts are generally used to fasten door hinges and body sheet metal in order to ensure the safety of passengers during car collision or rollover and prevent those fastened areas from deformation in accidents. When it comes to fastening, the issue of electrolytic corrosion due to the use of two types of different sheet metal must be taken into consideration.

-General thread connection: 1. Connection without nuts- bolts or screws can be used to fasten directly if sheet metal is thicker or only blind holes can be drilled; 2. Connection with nuts- Weld bolts or weld studs can be used. Weld bolts or studs onto sheet metal first, install mating parts, and fasten with general nuts.

-While adopting general thread connection, the anti-loosening of threads must be taken into consideration. There are two basic methods to ensure the anti-loosening of threads, which are preload control and pre-applied thread sealants.

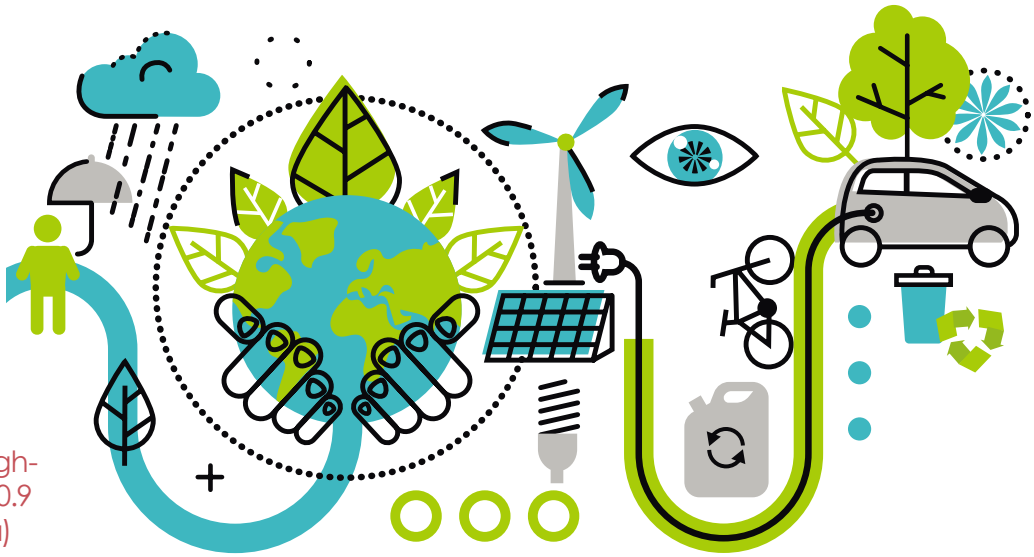
## Application of High-strength Bolts and Heat-resistant Bolts

Currently, Chinese new energy powered vehicles manufacturers usually use high-strength bolts of Gr. 8.8/9.8/10.9 or even Gr. 12.9 (1,200 Mpa) in 10B33, SCr440(40Cr), SCM435(35CrMo) and SCM440.

Under the trend of manufacturing more lightweight vehicles, manufacturers are continuously required to enhance the efficiency of power systems on one hand, and face stricter emission regulations on the other hand. Without doubts, high efficiency of power systems will result in higher pressure, temperature, and load, while stricter emission regulations also require less weight and internal friction.

In terms of design of bolts and studs used on new energy powered vehicles, designers not only have to consider the dimensions, materials, tolerances, and mechanical properties of bolts, but also have to fully consider in which environment the bolts will be used (e.g., high/low temperature, vibration, corrosion, etc.). The exhaust emission system has been always a thorny problem to the R&D of various car manufacturers due to the uniqueness of the environment where it is installed and the problem confronted in sealing connecting parts, so high-strength bolts and heat-resistant bolts were developed.

In response to the increasing demand for domestically produced heat-resistant automotive steel fasteners, China Society of Automotive Engineers has formulated T/CSAE99-2019 (Technical Conditions of Heat-resistant Steel for Automotive Fasteners) and T/CSAE136-2020 (Technical Conditions of Heat-resistant Automotive Fasteners), and China Fastener Standardization Technical Committee has also formulated GB/T3098.24-2020 (Mechanical Properties of Fasteners-Heat-resistant Stainless Steel and Nickel Alloy Bolts, Screws, Studs, and Nuts) and GB/T3098.25-2020 (Mechanical Properties of Fasteners- Guidelines for Selection of Stainless Steel and Nickel Alloy Fasteners). These standards mainly include relevant technical requirements for heat-resistant fastener materials, technical requirements for wire rod and coil, technical conditions for manufacturing heat-resistant fasteners and surface treatments, as well as technical conditions for assembly verification of force performance and torque testing systems, and requirements for marking, packaging, and delivery, which apply to engine fasteners (incl. bolts, dual-head studs, and nuts). The commonly used materials for manufacturing heat-resistant steel or nickel alloy fasteners in China are ML06Cr15Ni25Ti2MoAlVB (GH2132), ML04Cr11Nb, ML41CrMoV, ML21CrMoV, 14Cr17Ni2(1Cr17Ni2) and NiCr20TiAl (GH4080A). Although heat-resistant fasteners are usually made of heat-resistant materials with a high nickel and chromium content, they still have to be processed with correct heat treatment in order to bring the function of heat-resistant steel into full play. Therefore, heat treatment is a critical process to improve quality, durability, and reliability of heat-resistant steel fasteners.



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High-strength fasteners can provide higher clamping force, create smaller fastener dimensions, and reduce the total weight. Meanwhile, high-strength fasteners are also favorable to improve heat radiation and friction issues of new energy powered vehicles. Heat-resistant fasteners can be used to solve the problem of fastening failure in a high-temperature environment, as the increasing temperature in the exhaust emission environment of an engine will result in a change in mechanical properties of products, such as reduction in tensile strength and hardness that leads to creep or a change in metallographic structure that leads to fastening failure.

All in all, automotive fasteners are comprehensively used in various applications, so the conditions of use and failures differ quite a lot. Hydrogen embrittlement and fatigue failure of automotive fasteners used on new energy powered vehicles are the most common failures which result in the greatest loss. In the entire lifecycle of a car, fasteners are at risk of failure at all times. As a result, Chinese manufacturers should focus on design of fasteners, material selection, forming, heat treatment, surface treatment, assembly, and maintenance to control quality and prevent failure from occurring, which is important for China to improve its fastener manufacturing and application level and the reliability of its car manufacturing.