Advancing electric vehicle technology with cold-formed connectors

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With tightening regulations on CO_2 emissions even F1 is having to save fuel by making cars that are ever more efficient, proof of the inexorable move towards sustainability in automotive. Away from the racetrack we are now seeing significant progress in the shape of the increasing numbers of electric vehicles on our roads.

Manufacturers such as BMW and Nissan have successfully proved the viability of the market with their own electric vehicles; the Nissan LEAF became the best-selling electric vehicle in history during 2014 when sales topped 100,000[1]. According to the SMMT (Society of Motor Manufacturers and Traders), electric vehicle registrations in 2014 were up 10% on the previous year to a figure of almost 1.3 million[2].

Since the number of pure electric vehicle models in SMMT's registration database is now into double figures perhaps the most striking statistic is presented by the SMMT's table of the Top 10 lowest CO_2-emitting models[3]. Since all pure electric vehicles offer zero tailpipe emissions, the Number 1 spot in SMMT's Top 10 lowest CO_2-emitting models is shared between 11 such vehicles. And while such models continue to expand in numbers, no vehicle that is not purely electric has any hope of ever again entering the Top 10.

The engineering challenge

Although electric transport brings hope for enhanced future sustainability it also carries with it challenges for the engineering industry, as each advance in one stage of the power transmission chain requires others alongside to match it. The best current lithium-ion battery, which employs metal oxides in the positive electrode, cannot provide much more than 100 miles of service – not a viable solution for widespread take-up. And then there are charging stations to consider. As plug-in electric vehicle ownership continues to expand, so does the need for charging stations, with fast charging capabilities.

In addition to on-street facilities provided by electric utility companies, there are now mobile charging stations providing a range of special connectors to accommodate a variety of vehicles.

According to Richard Martin, editorial director for clean technology marketing and consultant firm Navigant Research, "Fast charging, however and whenever it gets built out, is going to be key for the development of a mainstream market for plug-in electric vehicles."[4]

So, enhancements to even the smallest components are required to establish the electric car as a serious competitor to petrol-powered transport. And such is the need to enhance sustainability – and the potential commercial reward for making a significant advance in the field – it looks likely that solutions will be found to circumvent any problem that stands in the way of electric vehicles.

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Powertrain innovations

Optimising powertrain efficiency is an excellent way to increase electric vehicle mileage and reduce energy consumption while maintaining performance levels and there has therefore been considerable innovation in this field.

For example, electric vehicle motors are engineered to run at extremely high speeds to increase efficiency and power density. In turn, this means that components such as bearings have to be engineered to minimise friction while operating for far longer periods than has previously been the norm.

To meet this need, bearings have been designed that combine design feature innovations such as optimised internal geometry, making them extremely robust and energy efficient at sustained high speeds. Innovations such as this are helping electric vehicle manufacturers to offer their customers increased mileage and overall improved robustness of the powertrain's key components.

Enhanced connectors

Similarly, recent advances in the manufacture of power connector technology are enabling designers to extract greater efficiency from motors and power trains. Power connectors are widely used in electric vehicles, for example in charging units and the motors used to drive each wheel. The focus for manufacturers is to find ways of improving the efficiency of power connectors to minimise power losses while reducing weight and cost.

One option is to engineer connectors using precision cold forming, which enhances part quality and significantly cuts metal waste.

Cold forming

Precision cold forming is capable of delivering precision engineered parts with up to 80% less scrap than other machining processes. Coupled with faster lead times, better surface finish and improved mechanical characteristics, precision cold forming offers an opportunity for manufacturers to take advantage of enhanced component quality while also reducing costs.

Performed at ambient temperatures, cold forming is a far quicker process than many competing techniques. This means that components can be made to order extremely quickly, cutting lead times and the need to store high volumes of spare parts onsite. Aside from tangible cost savings, cold forming makes for superior quality products by plasticising metals along their grain boundaries, rather than cutting across, thus producing parts with extremely low levels of stress deformation and high levels of mechanical integrity, resulting in far greater performance and reliability.

Furthermore, cold forming offers outstanding levels of definition, even on parts with complex contours.

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Dimensional tolerances can be to within plus or minus five microns, with the added benefit of extremely fine surface finishes, which in many cases require no further machining or polishing.

Additionally, parts undergo work hardening during the cold forming process, improving their machinability and durability still further. Work hardening reforms the structure of the metal in a way that prevents further dislocations, resulting in a stronger component.

As this increase in strength is comparable to that of heat treating, it can be more cost effective to cold work a less costly and weaker metal than to hot work a more expensive metal, particularly where a precision finish is required.

The cold forming process also makes it possible to produce component parts with a superior finish, both internally and on the surface. Accurate internal profiles and complex external profiles are possible, enabling precision parts to be manufactured; this can have a significant impact on the performance of the equipment in which they are used. Furthermore, there is almost no limit to the shape, size or complexity of the metal components that can be produced using cold forming. Simple or highly complex cold formed and finished machined components can be produced for a diverse range of applications.

At Dawson Shanahan, we have used our renowned precision cold forming expertise to manufacture power connectors that optimise the performance of electric vehicle charging units. Our high power connectors are generally produced from oxygen-free, high conductivity materials that are vital to ensure there are no power losses in this application.

References

1. Autoweek: Nissan Leaf tops 100,000 sales
2. SMMT: June 2014 - EV registrations
3. SMMT: New Car CO_2 Report 2014 (Chart 7)
4. Climate Wire

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