The recycled alumnium used in Jaguar Land Rover cars needs to meet specific input chemistry requirements. The challenge is finding a lower cost recycled material input.

# DRIVING ROUND IN CIRCLES

**The idea of buying a brand new car made from vehicle scrappage might seem ludicrous to many drivers, but the concept of car-to-car recycling is steadily gaining traction in the automotive industry.**

By Maxine Perella

Car makers are under increasing pressure to optimise the use of materials during the manufacturing process, both to reduce weight and tailpipe emissions, and to improve fuel efficiency.

One solution is to build a closed-loop value chain. Recycled aluminium, for example, requires up to 95% less energy during production than its virgin counterpart, and so by reclaiming some of the aluminium offcuts generated during the vehicle production process, car makers can make swift sustainability gains. Jaguar Land Rover (JLR) and Ford are two companies leading on such work. But in order to scale up these efforts, car makers will likely need to source greater volumes of scrap material from other, external waste streams – such as the end-of-life vehicles (ELV) market.

JLR's REALCAR (REcycled ALuminium CAR) project, running since 2007 in partnership with aluminium recycler Novelis and other key stakeholders, has enabled the car maker to take lightweighting to new levels – its XE, XF and F-PACE vehicle models now contain up to 50% recycled aluminium. During 2015-16, REALCAR reclaimed over 50,000 tonnes of JLR aluminium press shop scrap and fed it back into the production process through a closed loop system, preventing more than 500,000 tonnes of $CO_2$ equivalent from entering the atmosphere.

Last year REALCAR won further funding from Innovate UK to take forward the next phase of this work, called REALITY. The new 36-month project aims to explore the feasibility of sourcing post-consumer scrap aluminium from automotive sources for recycling and reuse in JLR cars. Adrian Tautscher, JLR's group leader for sustainable aluminium strategies, says that targeting material from ELVs will be the main focus, but adds: "We will continue to as-

Jaguar Land Rover is using up to 50% recycled aluminium in new cars in a project that is bringing benefits to itself and its suppliers.

sess the wider recycling opportunities as we progress through the project."

Under REALITY, ELVs will be shredded and automatically sorted using state-of-the-art sensing and sorting technologies to separate out wrought and cast alloys, before further separating the wrought alloys into different alloy types. These alloys will be melt conditioned to remove or tolerate impurities, from which full-scale recycled scrap-based sheet and castings will be produced and evaluated.

"Recycled sources need to meet our specific input chemistry requirements," explains Tautscher. "This requires separation to be at an alloy level. This includes separating wrought and cast grades and potentially sub-categories within these grades."

## COST EFFECTIVE VOLUMES

According to Tautscher, one of the critical considerations is assessing what volumes can be achieved from this process. Ultimately, JRL is looking for a consistent supply of recycled material in line with its current and future consumption of aluminium. "The challenge is finding a lower cost recycled material input, balanced by efficiencies in the separation process, to deliver an overall cost effective solution."

Projects like REALITY represent a great opportunity for the ELV sector, according to Robert Fell, chief executive of the British Metals Recycling Association (BMRA). "We'd like to see more push towards using secondary raw materials," he says. "Clearly there is an appetite by the car manufacturers to use more – it's going to be far in excess of what they generate themselves, and that's going to pull in our industry to provide a lot more post-consumer material to be able to feed that."

But there are several barriers to overcome first. A recent research paper examining circular economy opportunities for ELVs notes that while progress in ELV post-shredder sorting technologies shows good potential for high-level material recovery, "aside from a few exceptions, the sorted materials after shredding are often of insufficient quality to enable closed loop recycling". The study, Towards a Circular Economy for End-of-Life Vehicles: A Comparative Study UK – Japan, emphasises the importance of increasing vehicle dismantling rates – in a way that is cost-effective – to encourage greater reuse and recycling of ELVs.

Fell maintains that economics is the real sticking point here. He says while metal prices have fallen in recent years, the cost of treating ELVs has risen sharply and most customers are not prepared to pay a premium for higher value sorting and separation. "The problem is that the more work you put into dismantling a vehicle, or separation of the vehicle into ever smaller fractions of materials, the more cost you incur, and the lower your margin, until you get to a point where it's uneconomic." He takes steel as an example. "Because steel prices are so low, it's very difficult to do everything that needs to be done in terms of depollution and compliance, and still make money. And that is a really big challenge. If you have a car that has lot of aluminium panelling – there's a lot more value in aluminium than steel –it's easier to put more work into that vehicle."

## BETTER DESIGN

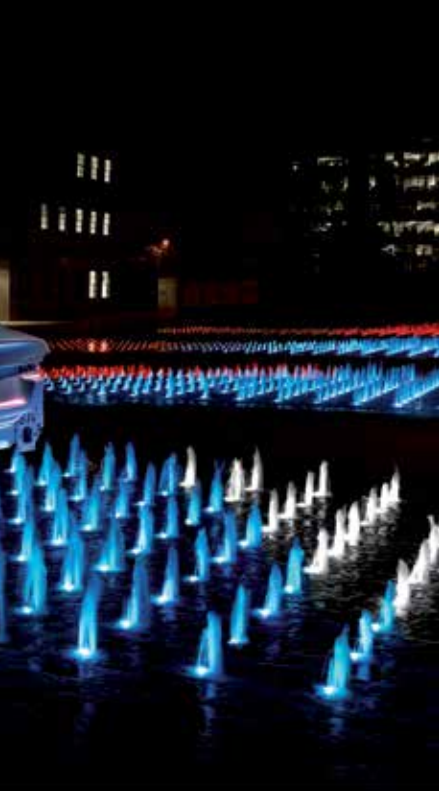
One approach that might help here is for car makers to design vehicles for easier disassembly at end of life. "If manufacturers are going to get any value from the circular economy, it needs to go directly back to

**FACTS**

**30,000**
Number of F-150 bodies Ford could make with the quantity of aluminium it recycles every month.

**7 MILLION**
End-of-life vehicles generated each year in Europe and over 3 million in Japan.

**40%**
Dismantling enables the recovery of up to 40% of the total ELV weight for reuse as spare parts and for recycling of large metal and plastics components.



Novelis, the world's largest recycler of aluminium, invested £6 million in new equipment to enable closed-loop manufacturing for the growing automotive aluminium sheet market.

Ford recycles as much as 20 million pounds of aluminium stamping scrap per month using the closed-loop system at Dearborn Stamping Plant, which provides parts to build F-150 at Ford's Dearborn Truck and Kansas City Assembly Plants.

design," says Eoin Bailey, a design engineer who has worked on resource efficiency issues within automotive supply chains.

He predicts that car manufacturers will increasingly develop design-led business models underpinned by circular principles. "They could look at designing in more effective disassembly processes, and offer a higher service-level agreement with their customers – to sell the car's use, through leasing and upgrade arrangements, and retain ownership of the car and its materials."

Bailey adds that car makers can also benefit from their supply chain infrastructure to help facilitate vehicle take-back and materials recovery – they just need to utilise them better. "They've got garages and service-level agreements with their customers throughout their entire network, they've got all these facilities available," he points out.

Toyota is pioneering some interesting initiatives on this front. In 2015 it announced a goal to establish a recycling-based society, focused on four key areas: the utilisation of eco-friendly materials; using parts for longer; developing recycling technologies; and manufacturing vehicles from ELVs. Building on this, last year the company embarked on two global rollout projects – the Toyota Global 100 Dismantlers Project, and the Toyota Global Car to Car Recycle Project.

The Dismantlers Project is aimed at driving global producer responsibility. Toyota has a target here to set up 100 ELV treatment facilities across the world by 2050, particularly in regions like South East Asia which lack the infrastructure and legislative mechanisms to process ELVs responsibly.

"Often these places are using used vehicles from other continents and when those vehicles reach the end of their life, there is no real requirement by law or from the producers themselves to treat those vehicles accordingly," says Steve Hope, general manager for environmental affairs & corporate citizenship at Toyota Motor Europe (TME). "We will be looking to form new partnerships with key stakeholders in those regions, to establish a network that would be able to help recover metals such as steel and other precious materials."

Hope says that in time, Toyota would be looking to take back some of these materials into its own supply chain. His colleague, Ronny Denis – general manager at TME – says there are important considerations that need to be taken into account first before this can happen at scale.

"Recycled material can contain many impurities. The automotive industry has one of the highest material specifications in order to guarantee product quality. These specifications can change over time as new vehicles are brought to the market, so it's not so easy to integrate recycled materials into this process," he maintains. "Also, you need to generate sufficient volume of recycled materials, a guaranteed flow that can feed the production line. All of these hurdles need to be overcome before we can integrate recycled material into new vehicles." In a significant move, Toyota has started to build easier disassembly into its vehicle designs. "I think we were the first car manufacturer to integrate an 'easy to dismantle' mark into our vehicles. This enables quick identification of specific parts on the vehicle that can be easily extracted. We have specific components which can be easily pulled out by dismantlers and recyclers, such as copper wire harnesses," says Denis.

He stresses that a balance needs to be struck however. "It's important to understand that this process can't compromise the safety and quality of our cars. For example, if you take a hybrid battery, the design of it can be difficult to disassemble, but that design is necessary to ensure the battery cells don't expand which would cause problems for the driver. You need to align quality and safety considerations with design for ease of recycling."

### CLOSING THE LOOP ON LIGHTWEIGHTS

On a strategic level, building in easier disassembly complements Toyota's car-to-car recycling project, which is linked to the company's development of lightweight materials such as aluminium and carbon fibre – materials which compen-

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general manager at
Toyota Motor Europe

sate for the weight of newer technologies such as hybrid batteries. "Unfortunately some of these lightweight materials do have a lot of energy and $CO_2$ embedded in them," says Hope.

Closing the loop on these newer types of materials will help offset some of that impact through the minimisation of life-cycle emissions. "For this project, we are specifically targeting materials used in hybrid batteries, also aluminium as we expand our aluminium range, and carbon fibre reinforced plastic," says Denis. "But we still have to undertake more technical and economic feasibility work, before we set any targets in terms of takeback volumes for these materials."

To give some idea of progress so far, since launching the Prius hybrid passenger vehicle in 1997, Toyota has collected around 55,300 end-of-life hybrid vehicle batteries as of March 2016, and is recycling all of them.

As well as developing technologies that will enable the nickel, cobalt and rare earth elements from these batteries to be reused in new hybrid batteries, Toyota has developed a solution for re-using these batteries either as replacement batteries or as stationary storage batteries in photovoltaic power generation systems.

As hybrid and electric vehicles become ever more common, both manufacturers and recyclers will have to adapt to optimise material recovery. As those materials change, there will be both opportunities and challenges. —