Can to Cars – an obvious environmental solution?

By Dr Geoff Scamans, Innoval Technology Ltd.

Nearly a quarter of all the UK's carbon emissions are produced by road transport. The simplest way to reduce CO_2 emissions from cars is to reduce vehicle weight. This makes aluminium an ideal material for the mass production of cars. If this aluminium could come from recycled scrap there would be a double benefit to the environment.

To date only two carbon significant aluminium intensive vehicles have been made in quantity, the Audi A2 and the Jaguar XJ. The Audi A2 1.2 Tdi clearly demonstrated the potential performance of an aluminium intensive vehicle with a fuel consumption of less than 3 litres/100km equivalent to a CO_2 level of 80 g/km. However, this car was not built with a manufacturing process suitable for cost efficient mass production and vehicle production ceased in July 2005.

The Jaguar XJ is made using a more conventional sheet intensive manufacturing route and although the key achievement of the Jaguar XJ is that it demonstrates that aluminium sheet can directly replace steel sheet for the mass manufacture of cars. However, the Jaguar XJ uses self piercing steel rivets rather than spot welds to make most of the joints. This is an expensive joining technology that would not be suitable for the mass manufacture of affordable vehicles and is not helpful for end of life recycling. As the life of spot welding electrodes can be significantly extended by the simple process of electrode buffing there is now no real barrier for the use of spot welding for the mass manufacture of aluminium intensive vehicles.

Aluminium is attractive as “lightweight” steel for the manufacture of cars in all aspects except the high cost of aluminium automotive sheet. The present price is directly related to the LME price and reflects the high energy cost of its primary manufacture. Worldwide the aluminium industry consumes as much electricity as the whole of the UK and uses about 10% of the world’s hydro-electricity to make more than 34 million tonnes of primary aluminium each year. This also produces around 250 Mt of CO_2 equivalent.

It is easy and much less energy intensive to recycle aluminium as it only uses 5% of the energy required to make primary aluminium. This is the basis for the extensive use of aluminium in beverage cans and why aluminium can compete successfully with steel in this application.

Presently the recycling rate of aluminium used beverage cans (UBCs) varies significantly from country to country and from state to state in the US. In the UK the recycling rate is about 40% and this means up to 3 billion aluminium cans (45 kt of aluminium) are lost to landfill each year. This is enough aluminium to make the body-in-white structure and closure panels for the 145,000 Ford Focus cars sold in the UK each year. If this lost aluminium was recovered every year for 10 years this could represent a vehicle fleet of nearly 1.5 million vehicles, each with a carbon emission of less than 100g/km, resulting in an impressive carbon saving of nearly 2 Mt of CO_2/year. This saving is about a 6% reduction in the estimated carbon emission from personal transport in 2017 (31.5 MtC). In the US this waste of aluminium is more dramatic and between 1970 and 2001 more than 910 billion aluminium cans were landfilled representing a loss of 16Mt of metal to be replaced by further primary production. Today this loss has exceeded more than 1 trillion cans (17.6Mt) that, for example, could have been used for the manufacture of the body-in-white structures of an impressive 117 million Audi A2 1.2 Tdi's.

UBCs are not the only source of old aluminium or post consumer scrap as it has been estimated that 70% of the 800 million tonnes aluminium smelted since 1888 is still in service. In 2004 about 3 million tonnes of old scrap was returned for re-use and by 2020 it is estimated that this will have increased to 14 million tonnes. Strong consideration should be given to upcycling as much as possible of this returning scrap into aluminium sheet for automotive manufacture rather than using it a source of metal for castings. Together with recycled "lost" cans this is the best way to build up the tonnage of aluminium for the repeated manufacture and recycling of automotive structures and panels for a significant fleet of low emission vehicles.

The alloy composition of remelted beverage cans is similar to the aluminium sheet alloys used for either automotive body structures (AA5754) or closure panels (AA6111 or AA6016). The structural alloy AA5754 would need to be more tolerant of iron and manganese compared to the present composition. The MCAST (Melt Conditioning by Advanced Shear Technology) process developed at Brunel University produces cast microstructures with increased tolerance to impurities and could be used to directly feed a twin roll caster to produce aluminium automotive sheet from recycled scrap.

The present price paid for aluminium can scrap (£700/tonne) is much lower than the primary metal price (£1575/tonne) and much higher than that paid for steel can scrap (£115/tonne). This price is presumably much closer to the real cost of can collection and return for reprocessing. It is very significant that countries and US states where there is a small deposit on cans have much higher rates of can recovery.

The time is right for a change of thinking on how to put significant tonnages of aluminium into a new generation of affordable, low carbon cars. The challenge is to make better use of old aluminium scrap as it becomes increasingly available, to embrace new technologies such as the MCAST process and specifically to stop the loss of precious aluminium cans to landfill.