Case Study: STL develops new Copper to Aluminium bonding technique for ZEV busbars

In late 2020, Samuel Taylor Limited (STL) secured Innovate UK funding as part of the ‘Catalysing Green Innovation: Securing the Future of ZEV’ competition.

The funding enabled STL to engage within a collaborative Innovate UK project titled ‘EVBus’, working alongside The Welding Institute (TWI Ltd) with the aim of investigating an innovative Copper to Aluminium bonding technique for use in zero emission vehicle (ZEV) busbars.

This represented the start of a working process that culminated in STL being able to create a proprietary cold-cladding process that they can now use to produce aluminium-copper bimetal strip.

The foundation for this was the successful development of a bonding technique that overcomes the challenge of aluminium’s high reactivity to oxygen - which makes it very difficult to bond cold.

In turn, this has great potential for industry, particularly aligned with the radical changes in automotive technology and the worldwide transition to EVs usage. This in-depth case study explores how the origins of these developments, why collaboration was instrumental and the significance of the outcomes for application within the EV industry.

Background:

Samuel Taylor Limited (STL) has been providing innovative, precision engineering products to markets throughout the world for over 100 years, pioneering the first electrically driven rolling mill in the early part of the 20th century and later becoming the first UK company to start electrical-contact welding in the 1960s.

With innovation at its heart, STL continues to lead the way with its unique combination of design capability, tool precision and manufacturing efficiency. This has enabled the company to project lead and manufacture leading edge components for the smart metering industry and focus on new areas in the growing EV market.

With a continual focus on research and development (R&D), and in the context of aiming to deliver more environmentally friendly, net zero-targeted solutions, STL – working in collaboration with The Welding Institute’s dedicated Thermal Processing Technologies (TPT) team identified a gap in the market for the manufacture of aluminium and copper bimetal connectors for the electric vehicles (EV) market in the UK and Europe.

These are particularly challenging to produce because current processes for joining the two metals together can result in the formation of excessive amounts of weak and brittle intermetallic phases, adversely affecting the structural integrity of the part. Therefore, it would require innovative thinking to create a new thermal processing technique.

STL had been considering for some time how to produce bi-metallic busbars, typically housed inside switchgear, panel boards and busway enclosures, for the EV sector. Busbars are used to connect low voltage in battery banks and high voltage equipment at electrical switchyards, as well as for high current distribution.

Several rounds of discussions identified topics of mutual interest, and STL explained their ambition to develop a new thermal processing technique for use in manufacturing busbars.

Consequently, the STL and TPT team conceived the idea of using an integral bonding approach instead of laser welding or wire bonding, both of which are used to produce connectors for the EV sector but known to have limitations. These include poor reliability caused by the number of joints required and the resultant heavier than desirable component weight, and the quality of joint achievable. When welding copper to aluminium or vice-versa, the aforementioned intermetallic phases will form, however, by making a bi-metallic strip, manufacturers can simply join copper-to-copper at one end and aluminium-to-aluminium at the other.

The TPT team then explored different ways of instigating such a project, which in turn led to the decision to bid for an Innovate UK Smart Grant. If successful, this would provide the funding for the initiative.

Project Objectives:

STL and TWI named their evolving project ColdClad – Development of an Advanced Cold Cladding Process for Electrification Applications – and set the following objectives:

- Develop, and demonstrate the validity of, a new process that project partner STL could use to manufacture aluminium and copper bimetal connectors for both the electrification and power supply markets
- Utilise an existing, known TWI joining technique as the basis for the new process
- Market mobilisation of the process by STL following proof of concept

Solution

The ColdClad project successfully secured Innovate UK funding (via a Smart Grant, reference 71790). As the partners progressed the project over time, it became evident that the original idea for ColdClad of starting from the basis of a known TWI joining technique would not work as originally envisaged, most likely due to equipment not being wholly large enough.

However, based on collaboration and innovative thinking, the two partners worked together to develop a rolled aluminium and copper bi-metallic strip (see Figure 1 below), with STL going on to create a new technique to enable the bonding of the two materials, and TWI providing specialist technical support.

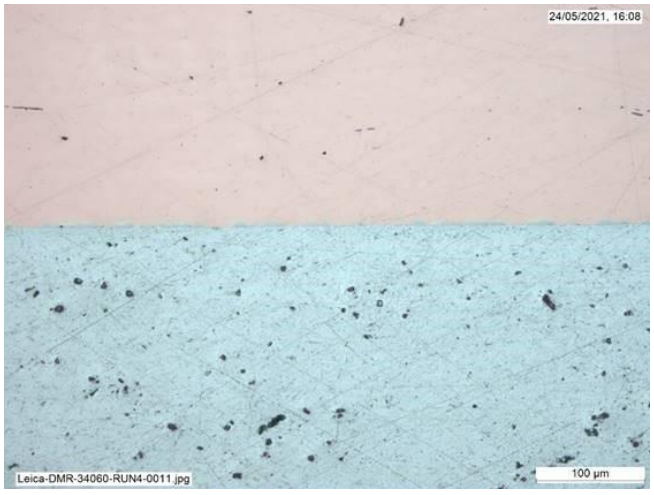

Figure 1. Early micrograph showing a diffusion bonded joint between aluminium: Al1050 and copper: C11000 Cu, optimised to reduce intermetallic thickness whilst removing all pores.

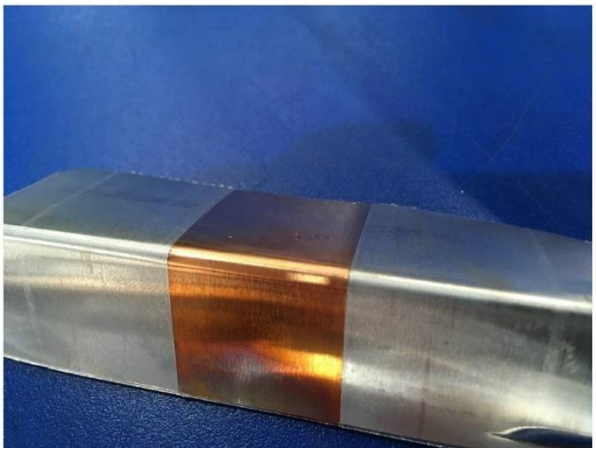

Figure 2. Example of a bend testing coupon of a bi-metallic sample showing a copper inlay within aluminium.

Benefits

Even though the diffusion bonding process investigated within ColdClad was not suitable for STL, the information gained during the project enabled TWI to develop an optimised set of parameters for joining aluminium to copper, with the capacity for further EV associated purposes beyond that of connectors.

The new joint type that is now achievable is also suited to many different applications, offering significant future potential for both the project partners and wider industry.

The work on the ColdClad project led to STL being able to create a proprietary cold-cladding process that they can now use to produce aluminium-copper bimetal strip.

The foundation for this was the successful development of a bonding technique that overcomes the challenge of aluminium's high reactivity to oxygen which makes it very difficult to bond cold (see Figure 2 above).

The innovative bonding technique now has great potential for industry, particularly within busbar technology found within the battery packs of electric vehicles (EV's). This represents a significant opportunity, given the worldwide transition to EV and ZEV usage. STL are at the forefront of innovating busbar technology for use within the EV industry and welcome conversations with other organisations within the global EV supply chain.

If you have a project of this nature and would like to discuss your requirements, please contact STL via sales@samueltaylor.co.uk

ENDS.

Further reading about this project:

https://www.twi-global.com/innovation-network/media-and-events/case-studies/twi-industrial-member-stl-develops-new-bonding-technique and

https://www.samueltaylor.co.uk/2020/stl-secures-funding-for-evbus-project/