Highly accurate manufacturing of complex aluminium parts employing vacuum brazing: role of process conditions on joint properties

What is vacuum brazing?

Vacuum brazing is a joining technology where two or more solid parts are connected through an intermediate layer of a filler material with a slightly lower melting point in a vacuum environment. The materials are placed in contact with each other and brought to a temperature just above the melting point of the filler material, where it spreads over the joint area through capillary action. Diffusion of alloying elements across the interfaces plays an important role as well. After cooling down a well-joined product is realized. Vacuum brazing is an interesting approach for the manufacturing of complex parts where dimensional tolerances are important or where many parts should be connected (for example: aluminium heat exchanger).

What is the problem?

Vacuum brazing takes place at high temperatures requiring excellent process control. Brazing times are usually short to prevent excessive evaporation of the molten filler material. The high temperatures may cause microstructural changes affecting the mechanical properties of the part. Typically, processes such as a grain growth and precipitate dissolution can take place that decrease the final strength and hardness. At the same time diffusion of alloy elements from the filler into the parts takes place. A good understanding of these processes is required to accurately predict the resulting strength of the final product.

In some cases, defects occur in some parts of the brazed regions requiring mechanical removal of these regions and a second brazing operation. It is not yet clear how well the brazing operation develops a second time when already significant diffusion of alloy elements across the interfaces has taken place. In-depth analysis is required to improve the understanding of the leading phenomena during multi step vacuum brazing of aluminium parts.

MSc assignment

In this MSc assignment you will study the vacuum brazing process and develop a deeper understanding of the main phenomena that determine the mechanical properties. You will concentrate on the material changes taking place during multiple brazing operations. A thermomechanical simulator to study the brazing process in detail is available to impose relevant temperature and pressure profiles over time. The research is done in close cooperation with NTS Norma in Hengelo who has state-of-art vacuum brazing facilities.

More information

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