Accumulative Roll Bonding of Lightweight Metal Composites

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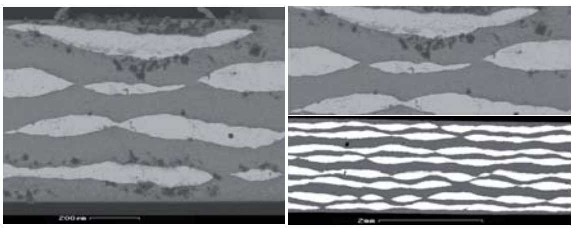
A key issue of the research is the investigation of Accumulative Roll Bonding in combination with other processes like Roll Bonding and Differential Speed Rolling. Accumulative Roll Bonding (ARB) was first published by Saito in 1999. It combines joint plastic deformation with severe plastic deformation. Two sheets are brushed on one side, each. These are placed together, facing each other and bonded together by roll bonding with a thickness reduction of 50 percent. As cold welding takes place during rolling a new sheet is produced. After rolling the sheet is divided in the transverse direction into two parts with the same geometry as the two initial sheets. By repeating this cycle, a large plastic deformation is inserted into the metal.

The applicability of ARB has been studied for various metallic elements and alloys like steel, copper, aluminum and technically important aluminum alloys. The development of texture, microstructure and mechanical properties has been studied mainly for aluminum alloys. By utilising ARB laminar material composites can be produced by combinations of different materials. In addition intermetallic phases can be generated. This in principle also holds for compounds such as γ-AlTi, which are important high temperature materials but are hard to roll to sheets. Therefore, it is advisable to roll the more easy formable metallic materials to sheets and start the reaction of the elemental foils into intermetallic phases subsequently.

The limiting factor of the reaction of titanium and aluminium to TiAl is the interdiffusion. By ARB the thickness of the individual layers can be reduced below the length which is affected by diffusion in a reasonable short time. In addition diffusion is accelerated due to the gain in free volume, the large volume fraction of grain boundaries and the high number of vacancies caused by severe plastic deformation.

A solid, light and tough material can be created by combining layers of a solid material such as titanium and a soft material such as aluminum. A commonly known example for a composite like this is the seashell. The main aim of this project is to investigate the parameters of the production of Al-Ti-layered materials. Because of the fact that the intermetallic phases are not desirable in order to maintain the ductility the possibility to separate the titanium and aluminum layers by niobium is also investigated.



Figures:

A) titanium layers are broken during the third rolling cycle, when pure Al and Ti are used.
B) no necking is observed up to the fourth rolling cycle while using a hard aluminium alloy and purity titanium.
C) necking starts also for the sandwich of Ti and a hard aluminium alloy at the fifth cycle but the layers are mostly still solid.