BLOODHOUND SSC'S WHEELS: INNOVAL TECHNOLOGY

The BLOODHOUND SSC Project is a global Engineering Adventure, using a 1000 mph World Land Speed Record attempt to inspire the next generation about science, technology, engineering and mathematics. This paper briefly summarises Innoval Technology's involvement in the project.

Who are we?

Innoval Technology provides high quality consultancy and technical support to investors, manufacturers and end-users of aluminium, and other selected engineering materials, across a broad range of industry sectors. The company is based in Banbury, Oxfordshire and employs 29 people. It is part of Danieli Group.

Basically, we're a group of aluminium experts! We know all about how it's processed and the products it goes in to. As you can imagine, we're doing a lot of work in the automotive sector at the moment. Our expertise covers metallurgy, surface treatment, lubrication and coatings and equipment engineering.

Why are we involved in BLOODHOUND SSC?

Everyone at Innoval Technology is passionate about inspiring the next generation of scientists and engineers. We also believe the BLOODHOUND SSC project provides a powerful means of showcasing the technical capabilities of aluminium, which is the material of choice for a host of parts from the car's wheels to some of its body panels. Many automotive OEMs are now turning to aluminium to make their vehicles lighter in order to reduce CO_2 emissions. For these reasons, we have offered our world-class aluminium expertise to the BLOODHOUND SSC engineering team as a Product Sponsor.

How are we involved?

Alloy selection, supply chain and defect analysis (see details below). Our analytical work will continue after the first desert runs in 2015. This is when we'll look at the surfaces of the desert wheels after they've been used.

One of our process engineers, Timothy Clemson, is a BLOODHOUND SSC School Ambassador (see below).

Alloy selection

The wheel alloy is aluminium AA7037 which is an aerospace alloy.

The initial alloy choices were AA2014 and AA7075 as these are the aluminium alloys used for aircraft wheels and had been used for earlier generations of land speed vehicles. As to why these were not chosen, please see below.

Impact Damage Trials and Surface Analysis

Initially we helped the team at Lockheed Martin, who were designing the wheels, to decide which alloy to use.

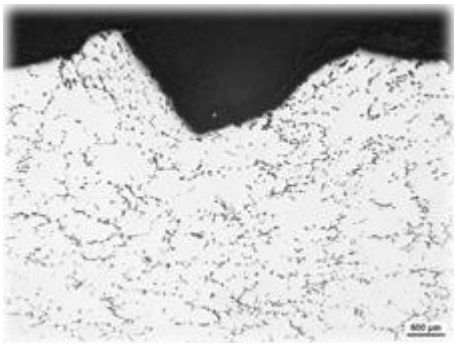
The two initially chosen alloys were assessed for impact resistance by firing particles of material from the run site (Hakskeen Pan, South Africa) at very high speeds at samples of the two alloys. We looked at the nature of the damage caused by impact of the high speed particles and found that this damage was minimal and did not result in cracks that would impair the structural integrity of the wheels.

The 'gas-gun' trials were undertaken at the Cavendish Laboratory (Cambridge) under the watchful eyes of the Lockheed Martin team. The trials investigated the damage introduced by the impact of rock particles, at approximately 1000 mph. There are more details on the BLOODHOUND SSC website:

http://www.bloodhoundssc.com/news/wheels-and-stones

Ten experiments were conducted, five on each aluminium alloy. No sub-surface damage was identified in any of the recovered samples, which suggests that both aluminium alloys responded to impact by plastic flow only. However, to be conclusive a more detailed metallographic analysis was necessary, and we took several of the worst-affected samples back to Innoval's test labs for further analysis.

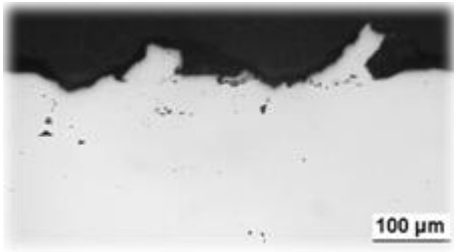
The image below shows an optical microscope image of an aluminium plate from one of the impact damage trials



We wanted to determine if any microstructural differences between the two materials could be observed after impact, and whether this could be used to rank the materials.

We used optical metallography to examine the projectile impact area to look for evidence of micro-cracking, and conducted Vickers microhardness (Hv) measurements to assess the extent of deformation hardening in the impact area.

In the region of projectile impact, there was some tearing of the aluminium surface, but no significant cracks were found. The subsurface region was hardened by around 5-10% to a depth of about 1mm below the impact crater. There were no significant differences between the behaviour of the two aluminium materials (AA7075-T651 and AA2014A-T651) so the stronger AA7075 alloy was selected.



This image is of aluminium alloy AA7075-T651 taken from near the centre of the spherical projectile impact

Following the impact trials we were asked by the Bloodhound design team if stronger aluminium alloys were available. We found that Alcoa (Aluminium Company of America) were about to introduce a stronger aircraft wheel alloy. This stronger alloy was a development of AA7075 with the designation AA7085. This alloy was not available in Europe so we found an equivalent alloy AA7037 made by Otto Fuchs. This alloy was available as large forgings suitable for wheel manufacture and was therefore the alloy of choice for wheel production for the desert wheels. The wheels for the runway trials were made from the AA7075 alloy as these could be machined form blocks.

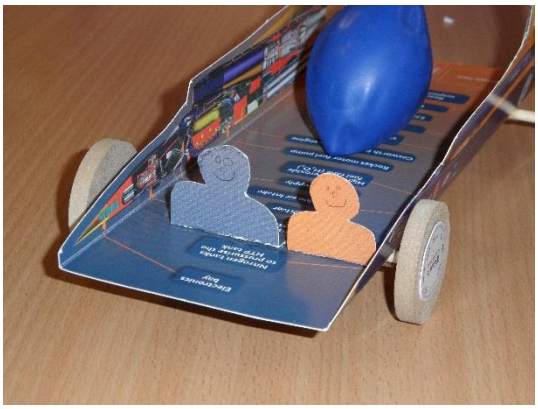
Innoval will carry out a detailed analysis of the forged and machined AA7037 alloy wheels after the first desert runs.

BLOODHOUND SSC Outreach Event

An important aim of the BLOODHOUND SSC project is to inspire the next generation of engineers. As well as creating a whole host of educational programmes, the BLOODHOUND team have recruited ambassadors whose job it is to visit schools and use BLOODHOUND SSC to communicate science and engineering in a fun and inspiring way.

Our own BLOODHOUND SSC ambassador, Timothy Clemson, recently visited a group of children at Warneford Hospital in Oxford. During the visit they watched inspirational videos about BLOODHOUND SSC and made balloon-powered models of the car. Then they carried out experiments to measure the thrust of their model cars using Newton's laws of motion and compared the results to the real thing. Thanks to Timothy and BLOODHOUND SSC, the children engaged in science in an enjoyable way, and all the comments we received were very positive. A member of staff even anticipated the children racing the cars along corridors well into the night!

A balloon-powered BLOODHOUND SSC from the event in Oxford:



Dr Tom Farley, Innoval Technology's MD, with Richard Noble and Andy Green:

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