PERFECTLY WELDED BATTERIES

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The manufacturing process for battery modules for electric cars demands utmost precision. Because the position and height of the battery cells vary due to production tolerances, the laser that welds the battery pole to the conductor plate must be positioned precisely for each cell. For this purpose, Manz AG has developed a laser welding machine that uses 3D laser triangulation to determine the exact height and position of the battery cells.

What the fuel tank is to cars with combustion engines, the battery module is to electric cars: the source of energy to drive the engine. Such a battery module is larger than a suitcase and weighs hundreds of kilos. Its design is surprisingly conventional, consisting of a group of many individual battery cells. Based on their shape, they are divided into prismatic, cylindrical and pouch cells. The cells are connected in series or in parallel to achieve the desired output voltage in combination with the required output current. To this end, thin metal strips are welded to the battery pole to create the desired circuitry.

The metal connections are welded with lightning speed using sophisticated automation – a hundred welding points per minute. However, this process was previously prone to problems, because the height of the battery cells is subject to production tolerances and their position in the battery pack frame also varies. Moreover, the welding laser that quickly fuses and joines the plates and battery poles has a small process window. If the laser is too close to the cell, there is a risk of it welding too deep and damaging the pole on the battery. If the distance is too large, the laser heats only the joining plate and not the connection to the battery. Under some circumstances, a correct connection cannot be achieved and the contact is lost later on.

A laser welding machine developed by Manz contains a measuring station that uses laser triangulation to precisely determine the position and height of the cells in the battery module in all three spatial dimensions. This makes the position of the welding point precisely known, and the laser’s process window can be moved accordingly. For this, the laser's lens – driven by a voice coil similar to the one in an audio speaker – moves up or down. The focal point moves along with it. To calibrate the sensor with the welding laser, there is also a camera mounted on the welding laser's scanner to take a two-dimensional black-and-white image, which is placed on the cover using the triangulation measurement.

The three-dimensional measurement of the welding points on the battery cells is done with the 3D laser triangulation method. A laser sensor moves over the entire length of the battery pack. The sensor throws fine lines of blue light on the top of the battery cells where the points for welding the connection strips are. A camera positioned inside the angle measures the reflected light. The known triangulation angle designates the object’s height lines. Height differences between the battery cells and the production tolerances for each individual cell appear in the images as stages in the line of reflected light. If the sensor head is moved in several paths over the entire battery pack, the individual recorded lines provide a three-dimensional height image of the entire battery pack.

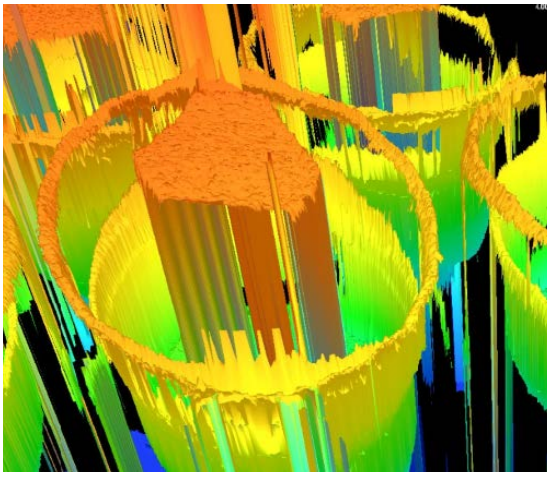
This height image is evaluated by software developed by Manz. It creates a height-encoded gray scale image in which it automatically finds prominent points and highlights them in color. The elevation in the middle of the cell is marked red; this is where the laser then welds the conductor for the positive pole.

At all points, the repeatability precision is less than 20 micrometers, so the process is actually precise enough for adjusting the laser's process window. The work speed is a major challenge. The combination of laser triangulation and welding lasers currently achieves more than 500 welds a minute. Customers want this to be even faster in the future. One idea for achieving this is to use two or more sensors instead of just one, each of which scan just a part of the battery pack.

The promise offered by this two-sensor strategy is confirmed by the four laser triangulation measuring stations that Manz has supplied to a notebook manufacturer. In that application, they determine the depth of the case to which the touchpad is precisely adapted. The touchpad's connection is seamless and can not be felt – an important criterion for the user’s perception of quality and ease of use. The measuring stations each have two sensors that achieve nearly double the work speed. The challenge to achieving adequately high throughput is the enormous quantity of data. For each measurement, the sensors generate 200 megabytes, which have to be processed within five seconds.

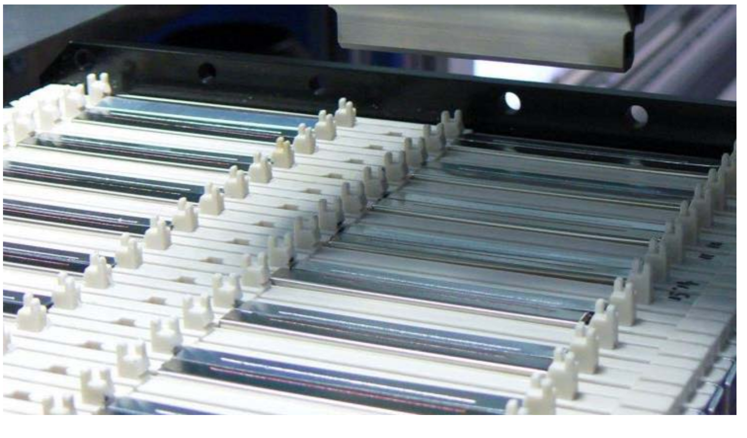
Manz has many years of experience with 3D laser triangulation. The company has previously used the method to determine the evenness of solar cells. For the notebook manufacturer, Manz is currently developing a system featuring a sensor with better optics and higher resolution. It is designed for an even more precise determination of the touchpad case depth.

Illustrations:



Three-dimensional measurement of the welding points on the battery cells is done with the 3D laser triangulation method.

A battery module consists of a group of many individual battery cells. A distinction is made between prismatic, cylindrical and pouch cells.



Welding battery cells with a laser process system