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Surface Characterization of CuCrZr-Electrodes for Resistance Spot Welding

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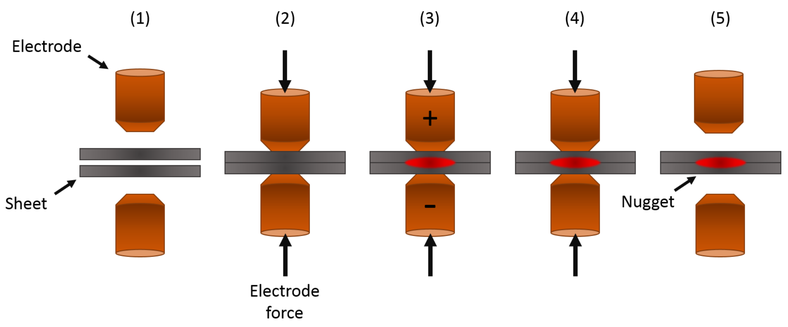
Introduction

Resistance spot welding is an established technology in the automotive industry because of the automatable process and the short welding times. Often the steel body sheet is welded with CuCrZr-Electrodes, which produce an irregular welded joint after a certain number of weldings. As a result the electrodes have to be bevelled or replaced which is a time-consuming and cost-intensive process.
It is presumed that adherences and diffusion processes at the interface limit the life time of the electrodes significantly. To prevent these processes a better understanding of the chemical interactions is essential. In order to this the surface of CuCrZr-electrodes is studied with spectroscopic (XPS, EDX) and microscopic (CLSM, SEM) techniques. For the experiments conventional steel plates with an AlSi-coating were used for welding. The electrodes were studied after 0, 10 and 100 welding processes, respectively.

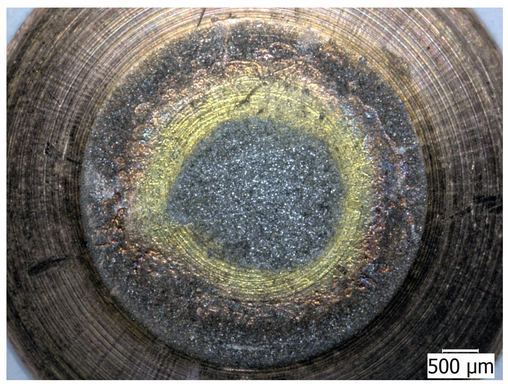
Resistance spot welding process

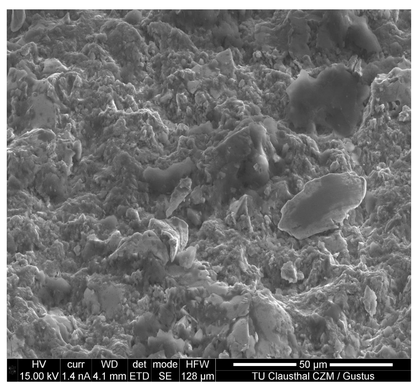


- Sheets: Usibor 1500-AS® from ArcelorMittal (steel 1.5528 with an AlSi-coating), 1.6 mm thickness
- Electrodes: CuCrZr-alloy, material number CW106C

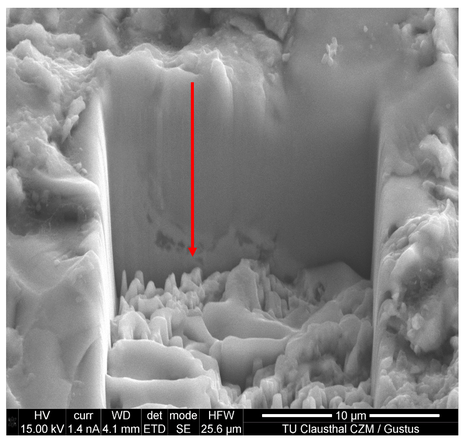
(1) Repositioning of the sheets
(2) Electrode force of 2 kN for a lead time of 1000 ms
(3) Two current pulses (9 kA for 20 ms and 5.7 kA for 270 ms) with a pause of 20 ms between the pulses
(4) Electrode force of 2 kN for a hold time of 200 ms
(5) Moving apart of the electrodes, process restarts

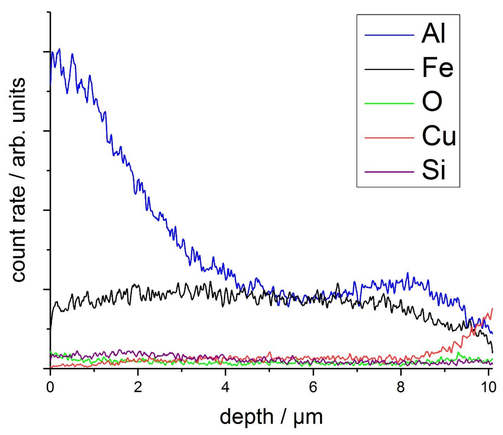
10 welding processes





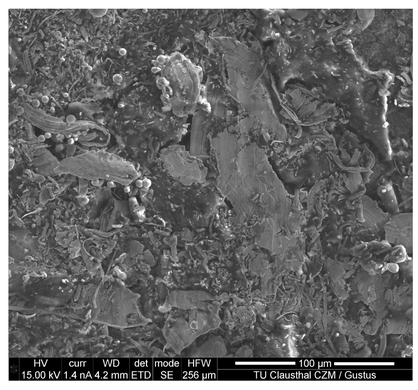
- Various adherences of AlSi-sheet material on the electrode surface
- XPS indicate a Cu(II) oxide layer on the surface and Cu(I) oxide below



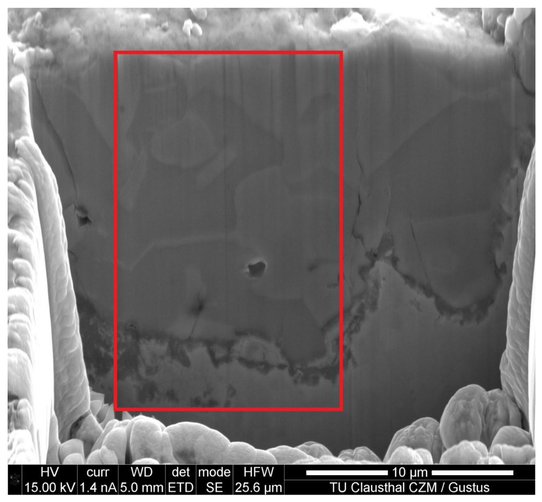


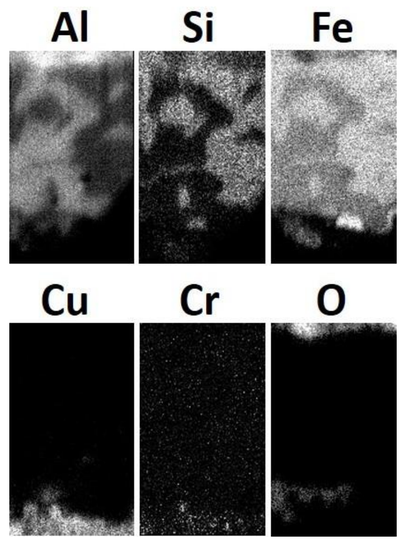
- 9 to 10 µm thick deposition of AlSi-sheet material
- Diffusion process at the interface of the CuCrZr-Electrode and the deposited AlSi-sheet material

100 welding processes



- Irregular weled joint, increasing size of weld spot
- Various adherences of AlSi-sheet material on the surface





- Up to 16 µm thick deposition of AlSi-sheet material on the electrode surface
- Two different phases in the deposition: A Fe-Si-rich phase and an Al-rich phase

Summary

- A deposition of AlSi-sheet material is formed on the CuCrZr-electrodes and the thickness increases with the number of welding processes.
- Diffusion processes at the interface of the deposition and the electrode in a range of 2 µm to 3 µm.
- Thermal and electric properties of the electrode surface are changed significantly so that the welding parameter lead to an irregular welded joint.

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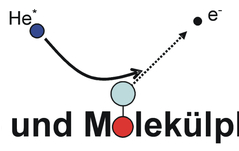

Atom- und Molekülphysik an Oberflächen

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