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Electrical contact behavior of clinched joints under short circuit conditions

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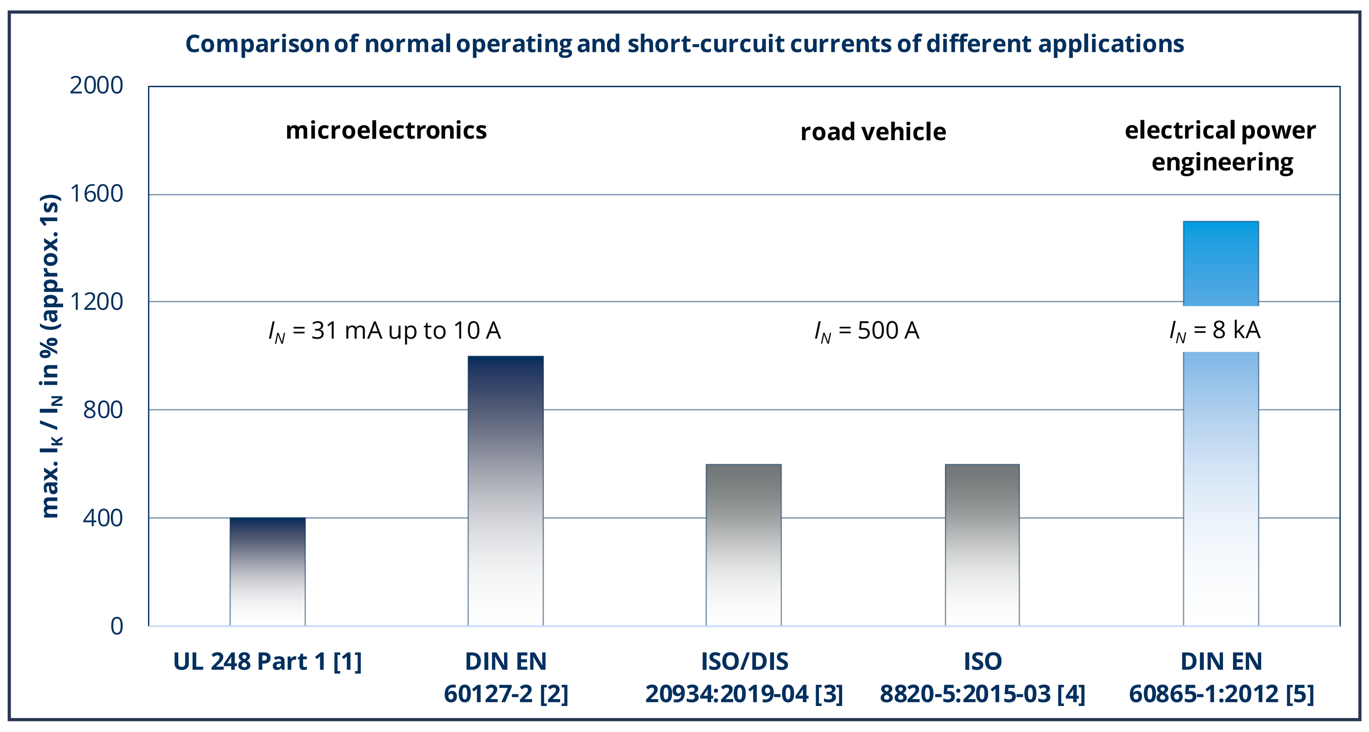
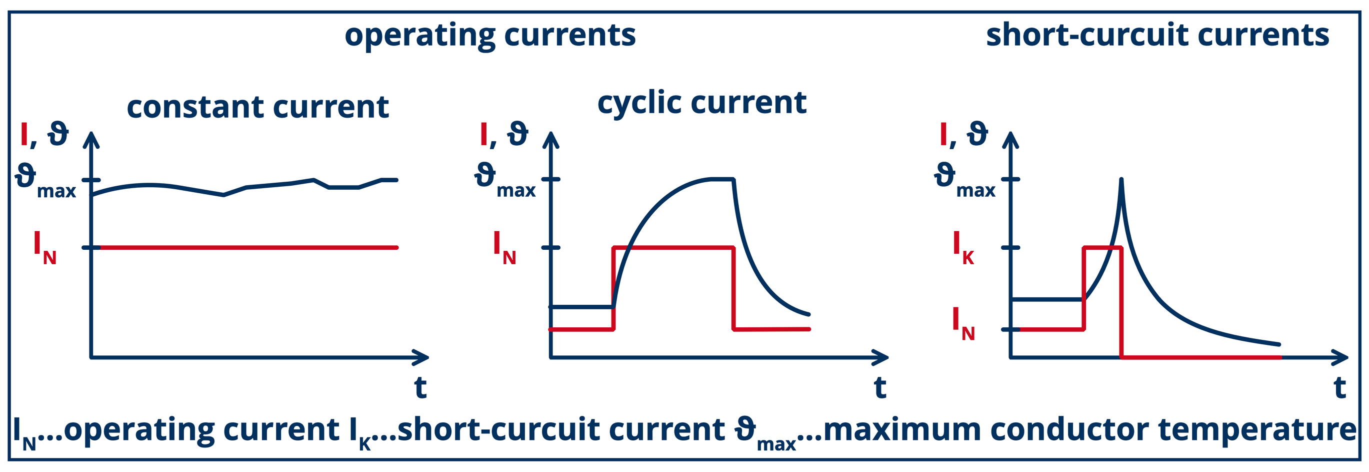
Introduction

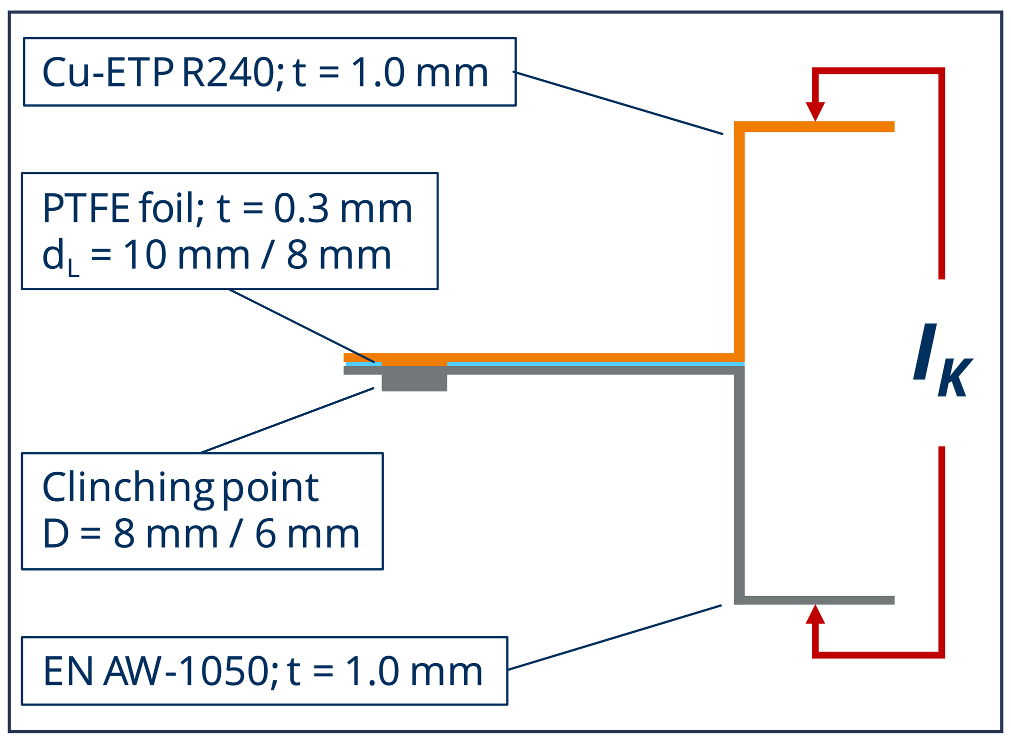
Clinched joints have previously been investigated and qualified with respect to their electrical properties and long-term behavior under normal operating currents. However, no findings are yet available on the contact behavior under short-time currents in the event of a fault. The short-time currents occurring in the event of a fault can be greater than the operating currents by a factor of 4 up to 15. The joint connections must be able to withstand the electrical, thermal and mechanical loads in the event of a fault in the network.



Objective

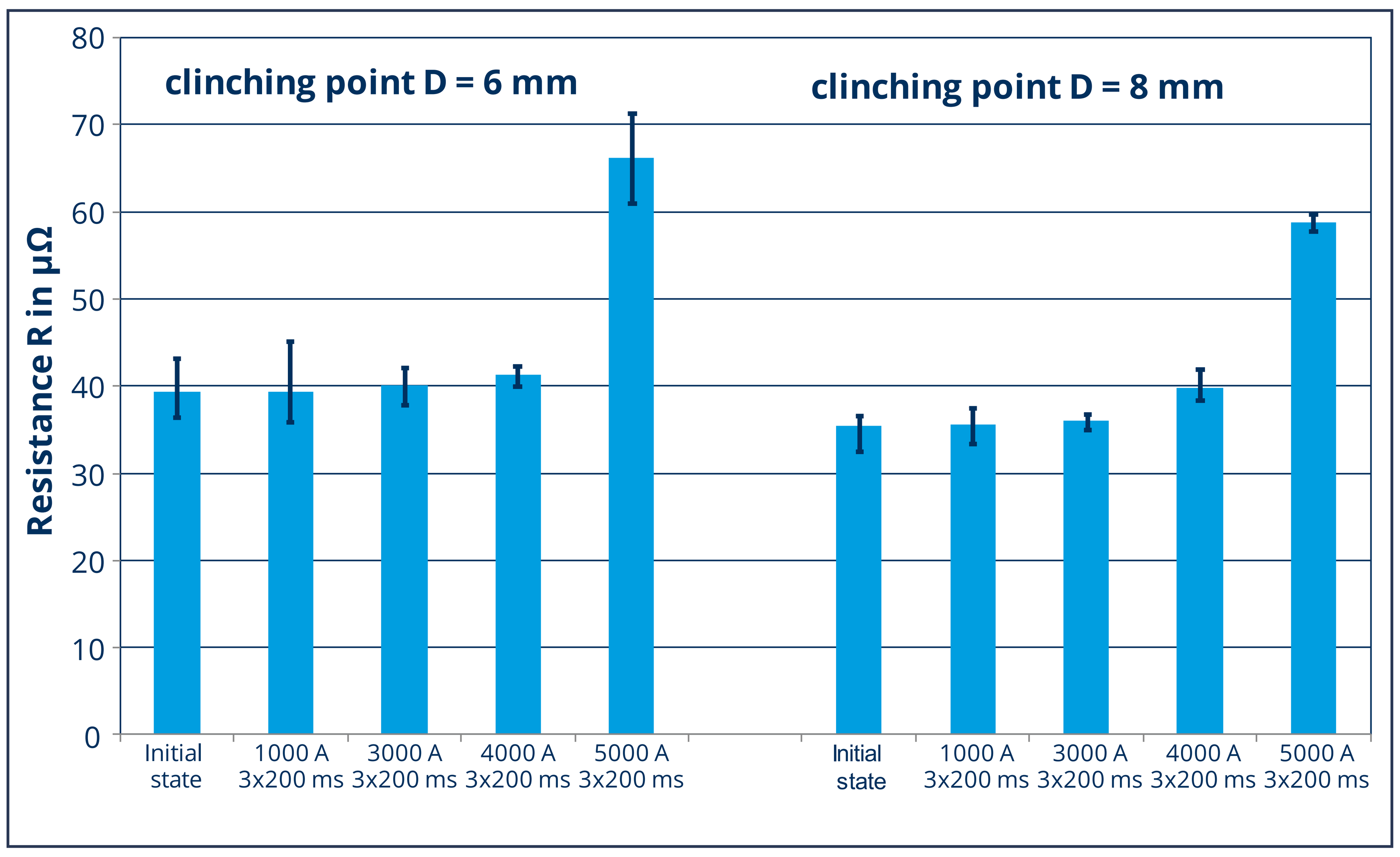
The aim of the work is to qualify the formed joints, in addition to mechanically fixing the components and carrying currents in normal operation, in terms of their ability to carry very high currents for a short time in the event of a fault. For this purpose, the processes in the boundary layers and the interaction of the various joining partners and surfaces under the influence of adiabatic heating and electromagnetic forces are considered by the short-time currents.





Methods & Results

To demonstrate the effect of a short-circuit current on a clinched connection, a copper-aluminium-connection was selected. To avoid shunts, a perforated PTFE foil was placed between the joining partners. The specimens were angled in order to be able to realise a current flow by means of a resistance spot welding system. The measurement of the connection resistance was carried out as a four-wire measurement over a measuring length of 19 mm. The connection resistance was determined on each sample before and after the current was applied.



Within the framework of preliminary tests, clinched joints with a point diameter of D = 6 mm and D = 8 mm were examined. It can be seen that the resistance does not increase at all or only increases slightly up to a current of 4 kA. When the samples are loaded with a short-circuit current of 5 kA, a significant increase in the connection resistance can be seen. The increase in resistance is greater at the clinch point with a size of D = 6 mm due to the smaller contact area.

Discussion

The acting short-circuit current leads to a local temperature increase in the clinched connections. In contrast to a cyclic current load, the clinching point heats up unevenly. Overtemperatures occur in the area of the microcontacts. If the limit temperature is exceeded, the contact behavior changes. This can be determined by the increased connection resistance. Due to the increased connection resistance, a higher conductor temperature will occur with continuous current flow. This in turn can lead to accelerated ageing and premature failure of the connection.
So far, no findings are available regarding the effect of short-circuit currents. In this case, it is necessary to gain knowledge about the maximum permissible short-term temperatures in the case of almost adiabatic heating in the contact. The mechanical stability of the joint must also be ensured for this case. These findings enable statements to be made as to whether the joint can continue to be operated after a failure or whether it must be replaced. A failure can occur directly after assembly or at any time during service life. The electrical contact behavior, the mechanical strength after loading with high short-circuit currents and their effect on the bonding mechanisms as well as the contact partners are to be investigated.

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