# The Mathematical Models of Welding Dynamics in Closed and Switching Electrical Contacts

S.N. Kharin, H. Nouri, T. Davies
University of the West of England, Bristol, UK

*Abstract* - **Welding in closed and opening electrical contacts is described mathematically by three models. The first model describes three-dimensional stationary temperature and electromagnetic fields in closed contacts. It relates to static welding, when the time of DC current passing through contacts is sufficiently large in comparison with the time required for attainment of stationary heat state. The second model depicts dynamical phenomena of welding in closed contacts with transient temperature at AC current. It takes into account the change of contact radius due to decrease of hardness and due to electromagnetic repulsion force at high current.. The special algorithm for the solution of this problem is elaborated and applied for calculation of melting and welding of contact region. The critical welding current and the dependence of welding area on current and properties of contact material are found and compared with experimental data. Criteria of weldability are introduced. Phenomenon of ring-shaped welding area observed in closed contacts at high values of current impulse and contact force is explained and described by the model considering solid-liquid phase transformation. Dynamics of welding at contact closure is considered as the chain of consecutive stages including breakdown, arcing, contact touch, melting and solidification of contact material. Two possible cases of contact behaviour following contact penetration and rapprochement stages at closure are considered and discussed. The first case is welding, which occurs just at the first touch if the time required for solidification of melted zone is less than the total time of penetration and rapprochement stages. The second one is a contact bounce with arc and welding at the second or next touches. The relationship between current, parameters of contact closure and contact material, which define immediate or delayed case of welding, are found and discussed. Results of calculations are compared with experimental data.**

***Keywords: contact welding, mathematical modelling, static and transient phenomena, welding during arcing***