Heat and Mass Transfer in Reactive Multilayer Systems (RMS)

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Abstract

Established joining techniques like welding, soldering or brazing typically are characterized by a large amount of heat load on the components. Especially in the case of heat sensitive structures like MEMS this often results in stress induced deformation and degradation or even damaging of the parts. One way of overcoming this problem are reactive multilayer systems (RMS) [1]. These foils consist of several hundred or up to thousand of alternating periodical reactive materials, like Al and Ni. An ignition spark activates atomic diffusion in z-direction (Figure 1) between the two reactive materials. Thus a thermal wave in x-direction (Figure 1) is generated. This wave transports the energy through the foil and activates the reaction of the materials. So a self-propagating front is formed. The released heat can be used to melt a solder (Figure 1). For industrial applications it is important to know the heat propagation into the joining components. Therefore, a mathematical model is needed to study the chemical and physical reaction in the RMS in order to be able to predict the heating of the components [2-4]. In this paper a two dimensional model is presented using COMSOL Multiphysics 3.5a. Dynamical atomic diffusion and heat are coupled in this model. The model shows the propagation of the thermal wave through the foil and the heating up of the joining components. From experimental data the reaction enthalpy and the propagation of the reaction front are used to calculate the temperature profiles. The results are correlated with experimental measurements.

Reference

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Figures used in the abstract

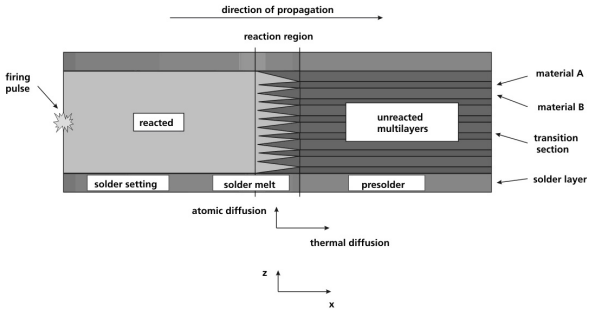

Figure 1: Principle of the reaction in reactive multilayer systems (RMS).