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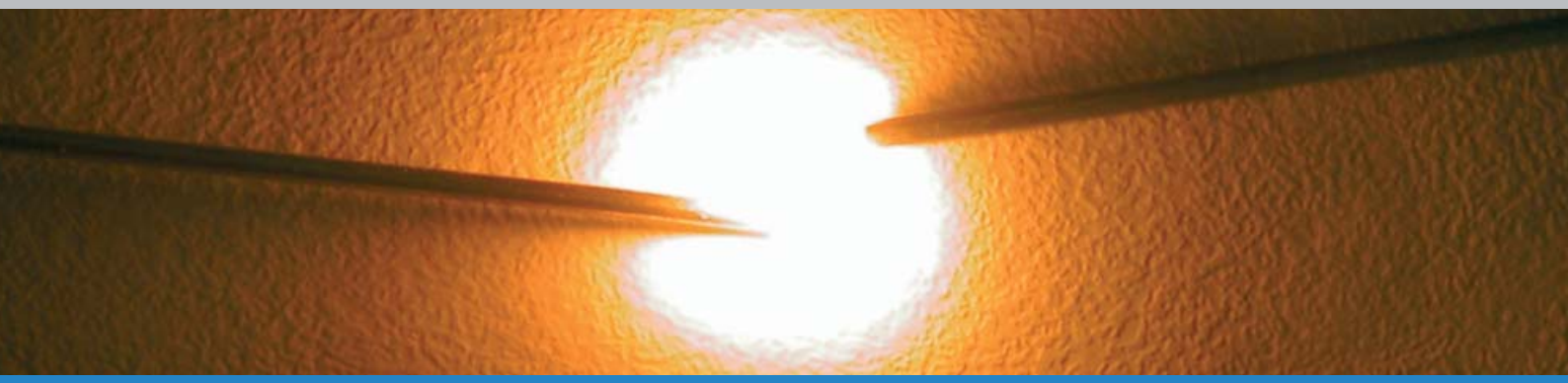

REACTIVE MULTILAYER SYSTEMS

Precisely controllable – local heat sources for joining processes without volume heating even at difficult-to-access positions

Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS
Winterbergstraße 28, 01277 Dresden
Germany

Fax +49 351 83391-3300
www.iws.fraunhofer.de

Contact:
Dipl.-Ing. Erik Pflug
Phone +49 351 83391-3524
erik.pflug@iws.fraunhofer.de

Dipl.-Ing. Georg Dietrich
Phone +49 351 83391-3287
georg.dietrich@iws.fraunhofer.de

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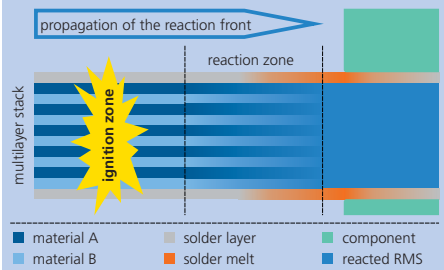
Task

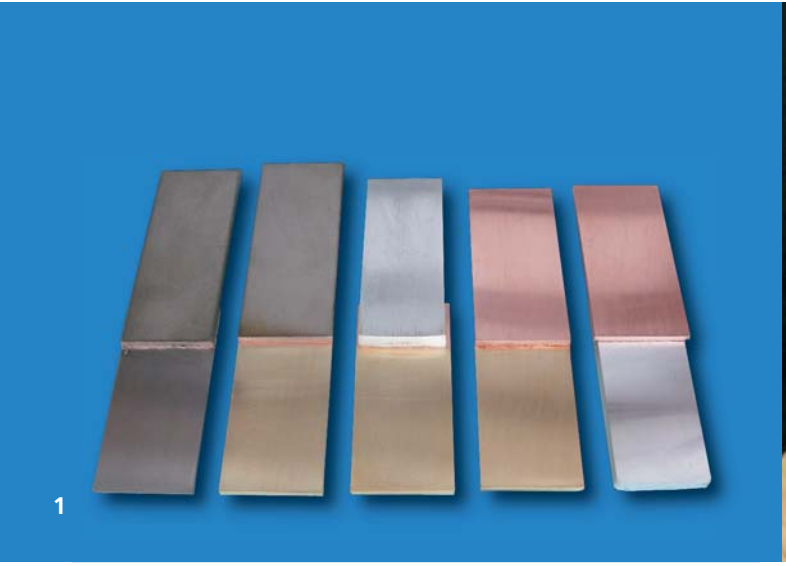
Soldering or welding procedures generally require a heating of larger joining zones at adjacent areas of the component which is to be joined. In order to avoid tension in the joint due to thermal stress and changes of material properties it is essential to have a heating source which directly delivers the heat to the joining zone with pinpoint precision, even at difficult-to-access positions.

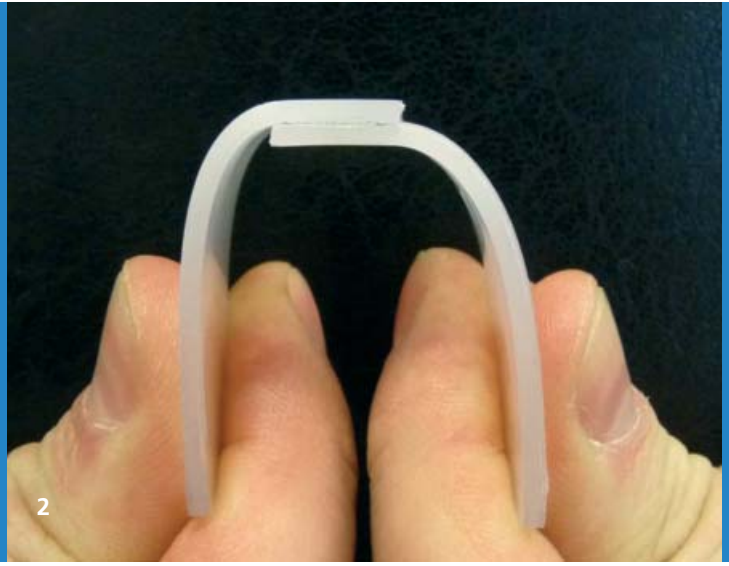
Solution

IWS scientists have developed an in-situ heating source, called reactive multilayer systems (RMS), which is perfectly tailored for particular joining tasks. RMS consist of at least two materials, which are stacked in several hundred single layers of only a few nanometer thickness. After the release of the activation energy the RMS react in a completely exothermic manner. The reaction heat can be used for the soldering or the melting of basic materials or solders. RMS can be either deposited on components or they can be fabricated as standardized, free-standing foils. Their total thickness lies in the range of 20 – 100 µm.

RMS setup and principle







Results

RMS offer the possibility to exactly tailor the heat energy necessary for the particular joining task. IWS researchers have developed low, average and high energy RMS material systems which allow for the melting of thermoplastics and even hard solder at temperatures of up to 700 °C. Additionally RMS enable the scaling of the heat amount with both the total thickness and the stoichiometric ratio of the reacting partners. Furthermore it is possible to equip RMS and components with a pre-soldering and thus provide a ready-to-use tool. If accurate geometries or preforms which are, for example, often required in the field of micro systems technology or housing engineering, RMS can be laser-structured. The reactive joining process occurs under pressure after the activation energy is released.

Possible applications

Micro systems technology and electronics
- hermetic sealing of cavities
- electric and thermal sensor contact
- bonding of Si-wafers on metal and ceramics
- electric contacting and bonding of diamond
- electric and thermal bonding of power electronics

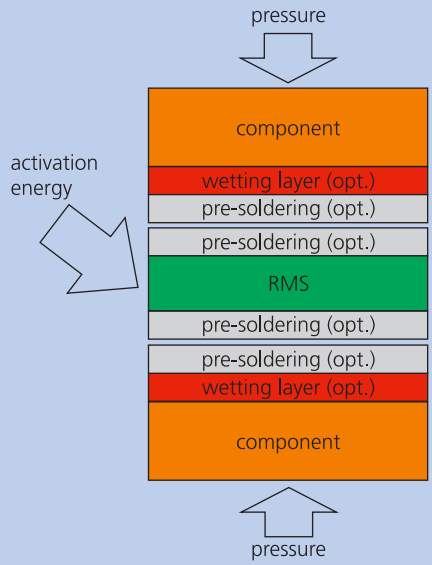
Polymer engineering
- body construction, housing industry
- metal – polymer – hybrids
- joining of difficult-to-access areas (pneumatics, housings)

Mechanical and plant engineering
- metal ceramics compounds
- medical technology
- joining of temperature-sensitive structures and components
- low distortion joining of diversified materials

Advantages

- in-situ heat source
- no heating necessary
- joining of various material combination possible
- hybrid connection possible
- very short joining time (less than one second)
- material-saving
- strengths of up to 40 MPa
- joining of thermoplastics and thermoplastic composites (CFRP, GFRP) without pre-treatment or surface activation possible

Schematics of a joining process by means of RMS



Parameters for the use of RMS

RMS materials:	Ni/Al, Ti/Al, Zr/Si, Zr/Al
RMS total thicknesses:	20 – 100 µm
period thicknesses:	25 – 100 nm
max. reaction temperatures:	800 – 2000 °C
reaction velocity:	2 – 11 m s^{-1}
required joining pressure:	0,1 – 50 MPa
joining time:	< 1s
joinable materials:	metals, ceramics, wafer, thermoplastics, CFRP, GFRP
usable solders:	Sn, SnAgCu, AuSn, $AlSi_{10}$, Incusil
activation energy:	electric spark, laser pulse
environmental conditions:	atmosphere, vacuum, fluids
max. RMS dimensions:	400 x 200 mm²

1 Reactively joined material combinations: steel – aluminum, steel – brass – aluminum – brass, , copper – brass, brass – copper – aluminum (f.l.t.r.)

2 Reactively joined thermoplastics (Polyamide PA6)