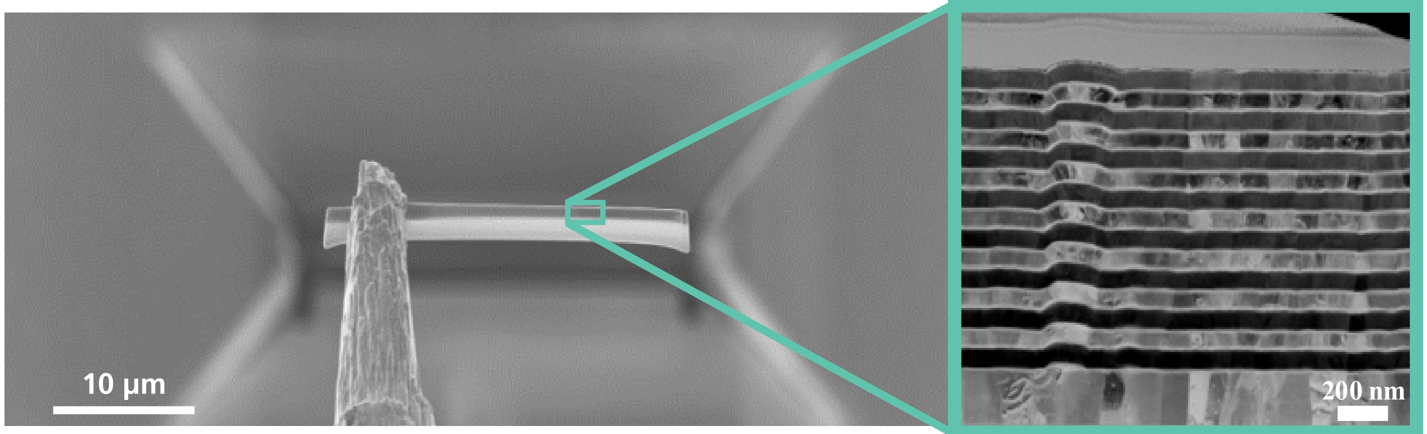
REACTIVE BONDING BY USING MULTI NANO LAYER SYSTEMS



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Description

The latest applications in microsystems technology require the integration of temperature sensitive components, such as polymers and organic materials, and other new materials, such as ceramics or metals, in one smart system. In addition to this Micro Electro Mechanical Systems (MEMS) devices, which are produced today, need hermetic packages. The hermetic sealing is done by wafer bonding. Here, typically used wafer bonding techniques are direct, anodic, adhesive as well as eutectic bonding. Among these methods, the bonding partners have to be heated up for a longer time, ranging from minutes to a few hours. This, however, makes the bonding of heterogeneous, or temperature sensitive materials difficult and increases the cost for waferbonding. Thus, new bonding techniques, which are operating faster at lower bonding temperatures have to be investigated.
A new, innovative method, which is able to ensure the above mentioned criteria, is the usage of reactive and nano scale multilayer systems (RMS). Such systems typically consist of several alternating nanoscale layers (see also Fig. 1). The intermixing of the individual layers results in a self-propagating exothermic reaction.
After initiation of reaction heat is generated in a fast self-propagating exothermic reaction (reaction velocities up to 52 m/s). This heat is used for melting of surrounding and, thus, generating the bond interfaces. One advantage of this technology is that the produced heat can be precisely controlled. Thus, the surrounding substrates are thermally damaged only to a minimum.

Advantages of the bonding technology

- Localized heating
- Very short bonding time (several milliseconds)
- Very high bonding strength (up to 340 MPa shear strength)
- No surface preparation necessary, such as plasma activation and native oxide removing
- Independent on bonding environment, such as vacuum or N_2

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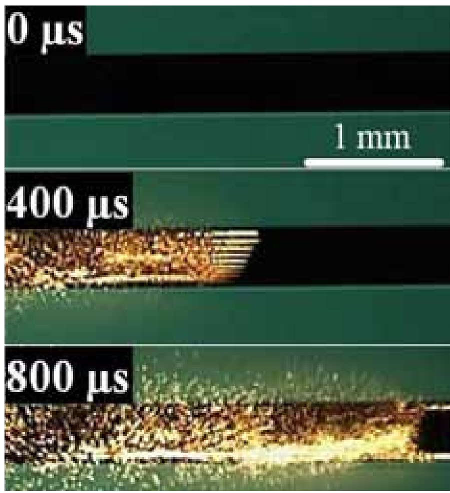

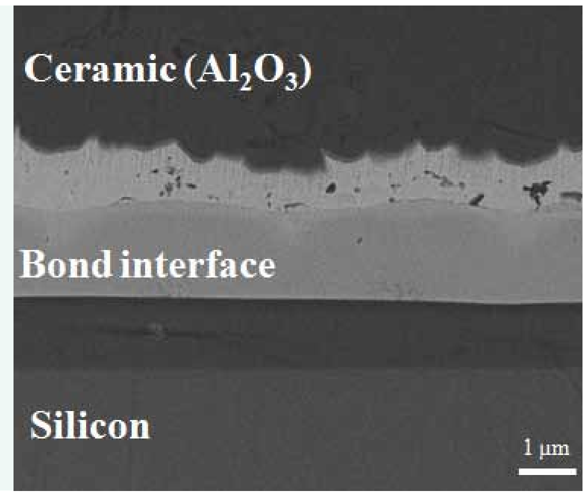

Successfully bonded material combination on chip and wafer level

	Si	Al_2O_3	Al	Borosilicate glass	Foturan glass	$LiTaO_3$	Covar	Cu	Stainless steel	Quartz
Si	x	x	x	x	x	x	x	x	x	
Al_2O_3	x	x		x				x		
Al	x		x	x	x					
Borosilicate glass	x	x	x	x	x					
Foturan glass	x		x	x	x					
$LiTaO_3$	x					x				
Covar	x						x			
Cu	x	x						x		
Stainless steel	x								x	x
Quartz									x	x

Figures:
page 1: High resolution images of reactive systems prior to initiation; page 2: High-speed time lapse images showing the reaction propagation (left); Bond 6” Si-glass wafer (middle), SEM cross section of a Si-ceramic bond interface (right)

Photo acknowledgements: Fraunhofer ENAS
All information contained in this datasheet is preliminary and subject to change. Furthermore, the described systems, materials and processes are not commercial products.

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