# Furnace-free Micro-joining with Reactive Nanofoils

G. Spinola Durante, R. Jose James, K. Krasnopolski, U. Lang •

*Reactive nanofoils are multi-layer foil materials that deliver energy in a fast and controlled fashion for micro-joining with typical bonding times of milliseconds. Applications can be found in many industrial areas like semiconductor, industrial, energy, medical and other market segments. Focus of this R&D activity is to develop a long-term reliable interconnection with customer-specific chip and substrate requirements.*

Micro-joining technologies are well established in the semiconductor and in the mechanical industries. Dedicated soft solder and brazing alloy solutions require to be performed in reflow-ovens, diffusion bonders or in general in heat-controlled environments. This is a limiting factor in a number of interesting cases for the industry segments above mentioned. In principle to join two components it is required to have only a heater foil and two solderable layers according to Figure 1.

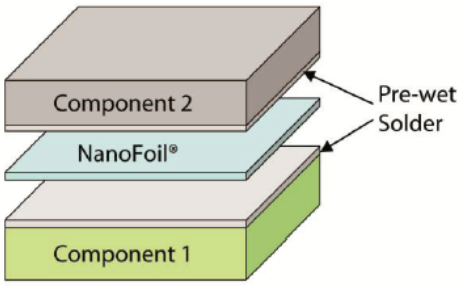


*Figure 1: bonding configuration using Ni/Al-based Nanofoil® (Courtesy: Indium Corporation).*

A furnace-free approach is considerably simple and enables to mount small components on large substrates without the burden of having a large oven. Large components also have a large thermal mass and most processes are easily limited by time due to cost and to technical reasons. Nanofoil® enables micro-joining with a heat wave travelling speed in the range of 5 mm/ms, independently of the substrate size and volume, making it possible to join components of very different geometric scale.

The fast nanofoils reaction also allows performing low-temperature bonding as the heat is only delivered to melt the solder layer and not to heat the bulk of the components to be joined. Simulations were performed to confirm that dissimilar materials with large thermal mismatch can be bonded with lower stress in the bulk of the component [1]. A typical application of Nanofoils is the bonding of > 10 cm sputtering high purity metal targets onto a copper holder for cooling purposes.

The specific Ni/Al Nanofoils material selected in this work has a specific advantage for both soft soldering and brazing. Nickel is an excellent wetting material for an extended range of solders and brazing alloys.

The foil is originally developed for large heatsink bonding, with a pricing which is highly competitive specifically on mm scale as compared to conventional furnace based bonding. This enables new applications where the extra accepted packaging costs are very low.

Focus of CSEM work is to investigate material combinations, bonding process parameter including pressure, temperature and cover-gas atmosphere to achieve a reliable and hermetic interconnect. The test dummies are prepared according to specific industrial areas requirements. A laser cutting process has been developed at CSEM which does not trigger the Nanofoil inherent exothermic reaction, in order to achieve the correct preform dimensions (Figure 2a). In Figure 2b the hybrid bonding of an AlN submount on a stainless steel substrate is shown.

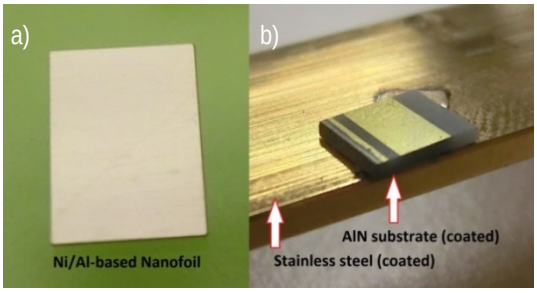


*Figure 2: a) Laser-milled Nanofoil®; b) Sample bonded with Nanofoil®.*

Many issues have to be tackled, depending on the selected chip and substrate combinations: de-adhesion of layers, partial bonding of Nanofoils and reliability issues like cracking of the multi-layer stack and low pull-strength and low shear-strength. Normed material testing is available at HSLU and through collaboration with CSEM will provide useful insight to the developed bonded configurations. (see Figure 3).

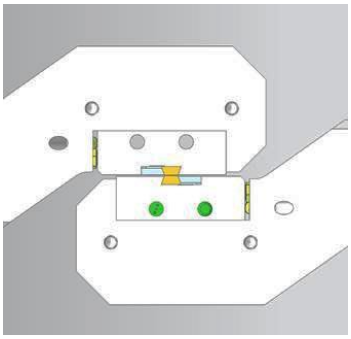

*Figure 3: Lap-shear Testing fixture for bonded samples in yellow color (courtesy: HSLU).*

CSEM can offer process development to any customer willing to test this new technology. Customization including samples specification and preparation, laser-cutting of Nanofoils is readily available.

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[1] www.techbriefs.com/dl/2013.php?i=15647&d=1