FACOLTÀ DI SCIENZE MATEMATICHE, FISICHE E NATURALI
DIPARTIMENTO DI MATEMATICA E FISICA "NICCOLÒ TARTAGLIA"

Development and application of nano-structured materials for nanojoining

Introducono:

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Abstract

With the continuing miniaturisation of micro-electronic devices and sensing components, the typical dimensions of interconnections and integrated components have crossed the micro-scale and entered the nano-scale. Hence, key technologies in the fields of e.g. microelectronics, sensing devices and medical implants have an urgent need for novel joining concepts to integrate, package and assemble micro- and nano-scale components at ever- lower temperatures with a precision down to the nano-scale (or even the atomic scale). As a result, the field of nanojoining is rapidly evolving and is expected to become an enabling technology for the large-scale production and broad application of advanced nanotechnologies in the coming decades [1-3].
This talk addresses current nanojoining research activities at the Swiss federal laboratories for Materials Science and Technology (Empa). For example, reactive nanomultilayers and nano-composite thermite coatings are developed for reactive joining of a wide variety of dissimilar materials at room temperature in air. In this case, the intimate contact between the fuel and the oxidizer is optimized by nano-architecturing to drastically enhance the exothermic reaction kinetics. Another important research activity is the development and application of sputter-deposited nano-multilayered (NML) fillers, which are constituted of alternating nanolayers (NLs; individual thickness ‹ 10 nm) of a metal or an alloy (e.g. Ag, Cu, Ag-Cu) and a chemically-inert barrier material
(e.g. carbon, nitride, oxide, refractory metal): see Fig. 1. These NML fillers are intrinsically thermodynamically unstable due to the high density of internal interfaces (phase and grain boundaries), which may invoke a significant melting point depression (MPD) of the nano-confined metal or alloy [4]. Moreover, the high density of internal interfaces in such NMLs provide short and fast diffusion paths at relatively low temperatures [2, 3]. The combination of both these nano-effects (i.e. MPD and fast diffusion along internal interfaces) may be exploited for localized interfacial bonding of micro- and nano-scaled systems at ever-reduced temperatures. Clearly, successful application of such advanced nano-joining technologies requires fundamental understanding of diffusion, wetting, nucleation, pre-melting and competing phase formation at reacting surfaces and interfaces at the nano-scale.

References

[1] J. Janczak-Rusch, G. Kaptay, L.P.H. Jeurgens, J. Matererials Engineering and Performance 23 (2014) 1608.
[2] M. Chiodi, C. Cancellieri, F. Moszner, M. Andrzejczuk, J. Janczak-Rusch, L.P.H. Jeurgens, J. Mater. Chem. C 4, 4927- 4938 (2016).
[3] J. Janczak-Rusch, M. Chiodi, C. Cancellieri, F. Moszner, R. Hauert, G. Pigozzi, L.P.H. Jeurgens, Phys. Chem. Chem. Phys. 17, 28228-28238 (2015).
[4] G. Kaptay, J. Janczak-Rusch, L.P.H. Jeurgens, J. Mater. Eng. Perform. 25, 3275-3284 (2016).

Seminario

Giovedì 16 marzo 2017
Sala Riunioni, ore 14.30
Via dei Musei 41 - Brescia

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