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Ni/Al multilayer nano films with increased reactivity

Ana Sofia Ramos[1], Sónia Simões[2], Jerzy Morgiel[3], Maria Teresa Vieira[1]

[1]CEMUC, University of Coimbra, Coimbra, Portugal [2]CEMUC, Department of Metallurgical and Materials Engineering, University of Porto, Porto, Portugal [3]Institute of Metallurgy and Materials Science, Polish Academy of Sciences, Cracow, Portugal

sofia.ramos@dem.uc.pt

Reactive multilayer thin films/foils are composed of tens, hundreds, or thousands of alternating individual layers of reactants having a large negative enthalpy of mixing. The layered structure is repeated throughout the film with a modulation period (Λ) consisting in the thickness of one double layer. The negative enthalpy of mixing of the constituents results in localized heat release once reaction is initiated. Therefore, nanoscale multilayers can be used as highly localized heat sources. Alternating nanolayers of Al and Ni, that constitute one of the most extensively studied reactive multilayer systems, have been successfully used for joining applications. For some years now, reactive multilayer foils are being used as local heat sources to melt braze alloys – Reactive Brazing. Taking advantage of the improved diffusivity and reactivity, metallic multilayer nano films have been used to enhance the diffusion bonding process – Reaction Assisted Diffusion Bonding. Reactive multilayers have also potential for self-healing purposes; the heat released after reaction can be used to melt a repairing material which will serve as a mobile phase to fill and close cracks. In this context, Ni/Al multilayer thin films with nanometric Λ were produced by d.c. magnetron sputtering from Al and Ni targets. Deposition parameters, such as targets' applied power, substrates' rotation speed, substrate bias, and deposition time, were varied in order to study their effect on the multilayers' reactivity. The multilayer nano films were characterised in detail by scanning and transmission electron microscopy. Phase identification was carried out by x-ray diffraction, while differential scanning calorimetry was used to estimate the heats of reaction. The objective is to fabricate Ni/Al nanomultilayers with enhanced reactivity to be incorporated in self-healing systems.

Keywords
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