EXMONAN

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Fast diffusion in nanostructured materials: new opportunities for joining technologies?

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The shortening of the diffusion distances when using nanosized joining materials characterised by high diffusion coefficients can reduce the time of the joining process from hours to minutes or even seconds. At the same time, as fast diffusion along the grain boundaries and internal interfaces in these nanomaterials occurs at room temperature already, the joining temperature can be shifted to much lower temperatures.

With the aim to utilise these advantageous material characteristics for the development of fast and benign joining processes, we developed and studied bonding materials in a nanomultilayer (NML) configuration [1-3]. The elevated temperature behaviour of such nanobonding materials (Cu/AlN, Ag/AlN, Ag/Ge/AlN, Ag-Cu/AlN NMLs) was studied in detail by ex-situ and in-situ XRD, HR-SEM, TEM, AES methods. Many parameters, such as the NML design (material specification, layer thickness, the number of layer repetitions), the morphology of the layers (in function of the deposition parameters), the structure of the interfaces, the internal stresses, the environmental conditions were found to affect the diffusion behavior of the investigated nanostructured joining materials. While the complex interplay of these parameters makes the understanding of the multilayer behavior very difficult, the resulting huge parametrical design space opens new opportunities for the development of nanojoining materials for fast, low-temperature joining processes or localized, selective bonding methods and properties.

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[3] J. Janczak-Rusch, M. Chiodi, C. Cancellieri, F. Moszner, R. Hauert, G. Pigozzi, L.P.H. Jeurgens, Phys. Chem. Chem. Phys. 17 (2015) 28228-28238.