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High velocity interfacial collision: Is it a potential method to produce a nanoporous surface?

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The magnetic pulse welding (MPW) is a solid state joining process,that enables a bonding of the interface for dissimilar metals. The development of the process has significantly benefitted from the knowledge of explosive welding, including the interfacial phenomena during the interpart collision. Previous research studies were generally focused on understanding the bonding mechanism that revealed in two main interfacial features: the interface morphology and the formation of intermetallic compounds at the interface. Investigation of the interface in this work led to the identification of nanoporous structure, which constitutes as a new key finding. As revealed in several SEM observations of aluminum/aluminum and aluminum/copper welded joints, nanopores have random sizes and allocations begin to appear within the intermetallic layers or pockets at low welding parameters. It is possible to obtain highly nanoporous zone with apparent high specific surface with an increase in the welding parameters. Since the intermetallic phase occurs by the melting induced collision, a phenomenology of pores nucleation, coalescence and growth within the molten intermetallic is suggested to explain the formation of the nanoporous architecture. The nucleation and growth may result from the cavitation phenomena by vaporization, surface tension of the fluid or confined bubbling. The coalescence phenomena explains the spherical shape of the porosity and the formation of the open pores as a result of a radial growth of vaporized nanopores. The fast cooling of the intermetallic freezes the porosity while the heat confined in the thin intermetallic (with few µm) quickly diffuses toward the both base metals, with large width and non affected by the heating except during the diffusion induced cooling. These consecutive phenomena potentially lead to the nanostructuration involved by the high velocity collision. Hence, the result shows a method for producing a nanoporous surface that merits to be further investigated. The major limitation of such method is the lack of proven knowledges about the mechanism involved in the nanoporosity formation despite the convincing results.

Keywords: magnetic pulse welding; molten intermetallic; nanopores; interface

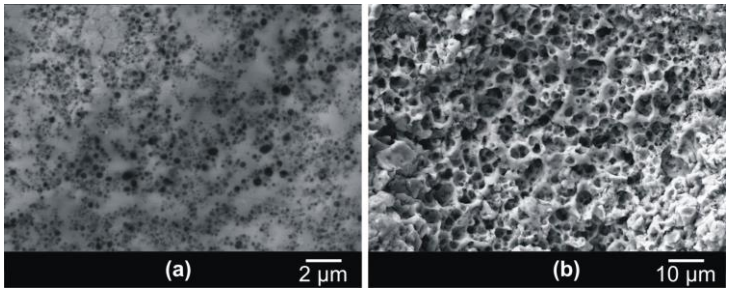

Fig. Typical nanoporous interface (a) and openpores with highly specific surface (b)