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In-situ Fabrication of a Metal-Intermetallic Composite: Microstructure Evolution and Mechanical Response

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Abstract : The role of different metallic and intermetallic reinforcements on the microstructure and the associated mechanical response of a composite is of crucial importance. To investigate this issue, a multiphase metal-intermetallic composite was in-situ fabricated through reactive annealing and accumulative roll bonding (ARB) processes. EBSD results indicated that the lamellar grain structure of the Al matrix after the first cycle has evolved with increasing strain to a mixed structure consisting of equiaxed and lamellar grains, whereby the steady-state did not occur after the 3rd (last) cycle—applying a strain of 6.1 in the Al phase, the length and thickness of the grains reduced by 92.2% and 97.3%, respectively, compared to the annealed state. Intermetallic phases together with the metallic reinforcement of Ni influence grain fragmentation of the Al matrix and give rise to a specific texture evolution by creating heterogeneity in the strain and flow patterns. Mechanical properties of the multiphase composite demonstrated the yield and ultimate tensile strengths of 217.9 MPa and 340.1 MPa, respectively, compared to 48.7 MPa and 55.4 MPa in the metal-intermetallic laminated (MIL) sandwich before applying the ARB process, which corresponds to an increase of 347% and 514% of yield and tensile strength, respectively.

Keywords : accumulative roll bonding, mechanical properties, metal-intermetallic composite, severe plastic deformation, texture
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