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An Analytical Systematic Design Approach to Evaluate Ballistic Performance of Armour Grade AA7075 Aluminium Alloy Using Friction Stir Processing

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Abstract : Selection of suitable armor materials for defense applications is very crucial with respect to increasing mobility of the systems as well as maintaining safety. Therefore, determining the material with the lowest possible areal density that resists the predefined threat successfully is required in armor design studies. A number of light metal and alloys are come in to forefront especially to substitute the armour grade steels. AA5083 aluminium alloy which fit in to the military standards imposed by USA army is foremost nonferrous alloy to consider for possible replacement of steel to increase the mobility of armour vehicles and enhance fuel economy. Growing need of AA5083 aluminium alloy paves a way to develop supplement aluminium alloys maintaining the military standards. It has been witnessed that AA 2xxx aluminium alloy, AA6xxx aluminium alloy and AA7xxx aluminium alloy are the potential material to supplement AA5083 aluminium alloy. Among those cited aluminium series alloys AA7xxx aluminium alloy (heat treatable) possesses high strength and can compete with armour grade steels. Earlier investigations revealed that layering of AA7xxx aluminium alloy can prevent spalling of rear portion of armour during ballistic impacts. Hence, present investigation deals with fabrication of hard layer (made of boron carbide) i.e. layer on AA 7075 aluminium alloy using friction stir processing with an intention of blunting the projectile in the initial impact and backing tough portion(AA7xxx aluminium alloy) to dissipate residual kinetic energy. An analytical approach has been adopted to unfold the ballistic performance of projectile. Penetration of projectile inside the armour has been resolved by considering by strain energy model analysis. Perforation shearing areas i.e. interface of projectile and armour is taken in to account for evaluation of penetration inside the armour. Fabricated surface composites (targets) were tested as per the military standard (JIS.0108.01) in a ballistic testing tunnel at Defence Metallurgical Research Laboratory (DMRL), Hyderabad in standardized testing conditions. Analytical results were well validated with experimental obtained one.

Keywords : AA7075 aluminium alloy, friction stir processing, boron carbide, ballistic performance, target
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