

## Tensile and Fracture Properties of Cast and Forged Composite Synthesized by Addition of in-situ Generated $Al_3Ti-Al_2O_3$ Particles to Magnesium

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**Abstract :**  $TiO_2$  particles have been added in molten aluminium to result in aluminium based cast  $Al/Al_3Ti-Al_2O_3$  composite, which has been added then to molten magnesium to synthesize magnesium based cast  $Mg-Al/Al_3Ti-Al_2O_3$  composite. The nominal compositions in terms of Mg, Al, and  $TiO_2$  contents in the magnesium based composites are Mg-9Al-0.6 $TiO_2$ , Mg-9Al-0.8 $TiO_2$ , Mg-9Al-1.0 $TiO_2$  and Mg-9Al-1.2 $TiO_2$  designated respectively as MA6T, MA8T, MA10T and MA12T. The microstructure of the cast magnesium based composite shows grayish rods of intermetallics  $Al_3Ti$ , inherited from aluminium based composite but these rods, on hot forging, breaks into smaller lengths decreasing the average aspect ratio (length to diameter) from 7.5 to 3.0. There are also cavities in between the broken segments of rods.  $\beta$ -phase in cast microstructure,  $Mg_{17}Al_{12}$ , dissolves during heating prior to forging and re-precipitates as relatively finer particles on cooling. The amount of  $\beta$ -phase also decreases on forging as segregation is removed. In both the cast and forged composite, the Brinell hardness increases rapidly with increasing addition of  $TiO_2$  but the hardness is higher in forged composites by about 80 BHN. With addition of higher level of  $TiO_2$  in magnesium based cast composite, yield strength decreases progressively but there is marginal increase in yield strength over that of the cast Mg-9 wt. pct. Al, designated as MA alloy. But the ultimate tensile strength (UTS) in the cast composites decreases with the increasing particle content indicating possibly an early initiation of crack in the brittle inter-dendritic region and their easy propagation through the interfaces of the particles. In forged composites, there is a significant improvement in both yield strength and UTS with increasing  $TiO_2$  addition and also, over those observed in their cast counterpart, but at higher addition it decreases. It may also be noted that as in forged MA alloy, incomplete recovery of forging strain increases the strength of the matrix in the composites and the ductility decreases both in the forged alloy and the composites. Initiation fracture toughness,  $J_{IC}$ , decreases drastically in cast composites compared to that in MA alloy due to the presence of intermetallic  $Al_3Ti$  and  $Al_2O_3$  particles in the composite. There is drastic reduction of  $J_{IC}$  on forging both in the alloy and the composites, possibly due to incomplete recovery of forging strain in both as well as breaking of  $Al_3Ti$  rods and the voids between the broken segments of  $Al_3Ti$  rods in composites. The ratio of tearing modulus to elastic modulus in cast composites show higher ratio, which increases with the increasing  $TiO_2$  addition. The ratio decreases comparatively more on forging of cast MA alloy than those in forged composites.

**Keywords :** composite, fracture toughness, forging, tensile properties

**Conference Title :** ICACM 2016 : International Conference on Advanced Composite Materials

**Conference Location :** New York, United States

**Conference Dates :** June 06-07, 2016