ABSTRACT

The present investigation establishes a liquid processing route where thermit based reactions have been used to synthesize in-situ TiC-reinforced as well as ZrC-reinforced Fe-based composites in a single step. The TiC-reinforced Fe-based composites have been synthesized by aluminothermic reduction of siliceous sand, a waste product of aluminium extraction plants, containing oxides of different elements like Fe, Ti, Si, etc., in the presence of carbon (C). The ZrC-reinforced Fe-based composites have been synthesized by aluminothermic reduction of blue dust (Fe_2O_3) and zircon sand ($ZrSiO_4$) in the presence of C. The ZrC-reinforced Fe-based composites have also been synthesized by a two-step process, where in the first step, Fe-Al-Zr-Si master alloy has been synthesized by aluminothermic reduction of Fe_2O_3 and $ZrSiO_4$. In the second step, this master alloy has been dissoved in molten mild steel to synthesize the ZrC-reinforced Fe-based composites. The process parameters for synthesis of composites have been optimized.

The composites have been synthesized with varying matrices and reinforcement volume fractions, and subsequently characterized by techniques of optical microscopy, scanning electron microscopy (SEM), x-ray diffraction (XRD), and image analysis. The mechanical properties such as impact toughness and tensile strength of few selected TiC-reinforced and ZrC-reinforced Fe-based composites have been evaluated. Macrohardness of all the composites in as-cast and heat-treated condition as well as hardness of individual phases of the composites have been determined. The abrasive wear behaviour of the composites has been evaluated.

The TiC-reinforced Fe-based composites have shown very good abrasive wear resistance property and high hardness values. However, the microstructures of TiC-reinforced Fe-based composites are not stable at high temperature due to the non-stoichiometric nature of TiC particles. The ZrC-reinforced Fe-based composites have been found to posses promising abrasive wear resistance property along with good high temperature stability. The feasibility of TiC-reinforced Fe-based composite as a

cutting tool material for machining mild steel has been evaluated. It has been found that it may be used at low cutting velocity under cutting fluid condition.

Key words: Iron-based composites, TiC, ZrC, non-stoichiometric, abrasive wear, machinability.