# Dry Wear of AA1100/Titanium Oxide Metal Matrix Composites

**N. Ramdas Gupta**
PG Student, Department of Mechanical Engineering, JNT University, Hyderabad

**Under the Guidance of Dr. A. Chennakesava Reddy, Associate Professor, JNTUH College of Engineering, JNT University, Hyderabad.**

## ABSTRACT

In manufacturing industry, there is continues demand to develop light weight, inexpensive and strong material. This demand has led to the development of aluminum alloy metal matrix composites. The reinforcements for MMCs can be broadly divided into four major categories, viz. Continuous fibers, discontinuous fibers, whiskers, and particulates. The reinforcements are generally ceramic; which can be oxides, carbides and nitrides which are used because of their excellent combination of specific strengths and stiffness at both ambient and elevated temperatures. The different techniques employed for metal matrix composites are powder metallurgy, spray deposition, liquid metal infiltration, squeeze casting, stir casting, etc. All of them have their own advantages and disadvantages. Among the various processing techniques available for particulate or discontinuous reinforced metal matrix composites, stir casting is the technique which is in use for large quantity commercial production. In the particulate metal matrix composites, the particle size varies from micron to nano. Advantage of using nanoparticles as reinforcement is that their size is smaller than the critical crack length that typically initiates failure in composites. However, agglomeration of nanoparticles is the major problem. In fact, several investigations have shown that small levels of agglomeration can decrease the strain-to- failure by several tens of percent. The major obstacle is the formation porosity during materials processing.

The present investigation has been focused on the micromechanical and wear behavior of AA1100/titanium oxide metal matrix composites with different composition (10%, 20% and 30% by volume of AA1100 alloy of titanium oxide ($TiO_2$). Bottom-up pouring was used to produce the composites. Tensile and sliding wear test were conducted on these MMCs. Also, the effects of particle clustering and porosity on micromechanical behavior were analyzed using experimental procedure and finite element method (FEM). Two models were used in the computational framework. The first one is uniform distribution of nanoparticles without clustering and porosity. The second one is with clustering and porosity.

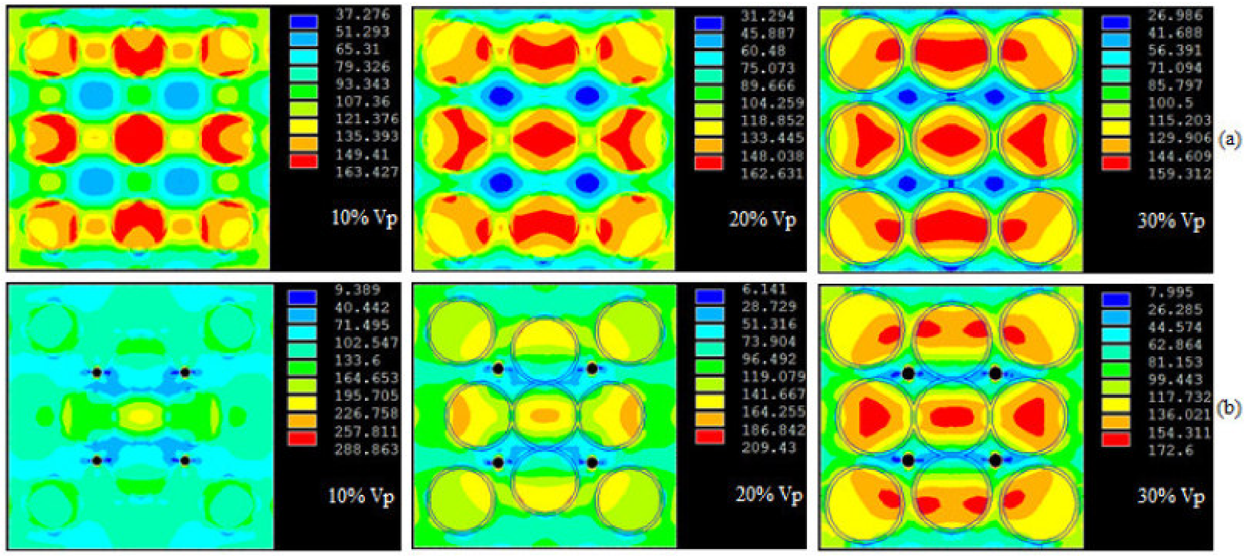


Figure 1: Images of von Mises stresses obtained from FEA: (a) without clustering and porosity and (b) with clustering and porosity.

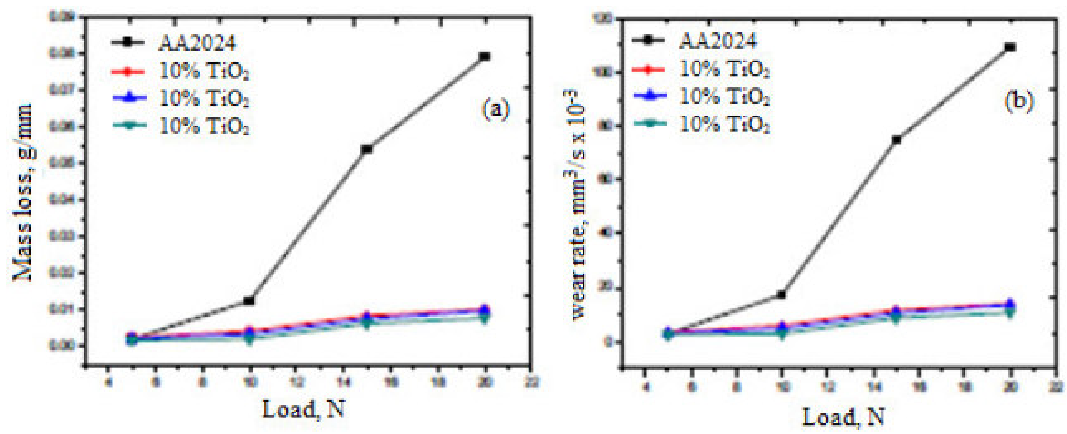


Figure 2: Wear analysis of AA1100/$TiO_2$ composites: mass loss and (b) volumetric wear rate.

AA1100/ TiO2 metal matrix composites had clusters and porosity voids. The stress intensity was increased with porosity and clustering of graphite nanoparticles. The wear loss has decreased with increase of volume fraction of $TiO_2$ in AA1100 alloy matrix.

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