Effect wt% Magnesium On Hardness and Wear Resistance of Ceramic Matrix Composite Al₂O₃/Al Produced by Directed Metal Oxidation (Dimox)

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Abstract -- This research aim is to observe the effect of wt% Mg on hardness and wear resistance of ceramic matrix composite produced Dimox with and no pre-form. The various of wt% Mg in this research is chosen 5%, 8%, 10% and 14%, which for compaction pre-form Al₂O₃ and Mg powders is mixed and then added full hydrolyzed PVA with 50 Bar load. The materials ceramic matrix composite is produced by Al ingot which placed below Al₂O₃ and Mg powders in a crucible and heated at 1300°C. Testing result show that the hardness of the compaction pre-form is higher than uncompaction pre-form. On the contrary wear resistance of compaction pre-form is lower of compared uncompaction pre-form.

Keywords—wt% Mg, hardness, wear resistance, dimox

I. INTRODUCTION

Ceramic matrix composite (CMCs) currently has become an alternative material in various fields, and innovative development primarily is subjected to components need reduce in weight and cost in manufacture(1). CMCs development is caused by its ability in giving some appropriate advantage characteristics for a certain application such as strength, toughness, hardness and high heat resistant(2).

At the beginning of oxidation process, include aluminum forms a thin layer on the surface. Though the thickness of the layer is not more than two nanometers, it can be penetrated easily, very stable and its oxide layer is coherent, to prevent further oxidation process due to oxygen pressure.

This protective oxide layer can be soluted by lanxide process with adding dopant so then the oxide layer become unprotective. Low wetting in metal ceramic system can be increased by dopant addition. Though the effect of dopant addition on aluminum oxidation is not so important, merely the dopant addition can increase penetration of capillarity on oxide layer covering metal melt susceptible forming metal/substrate interface. Dopant give influence to surface stress either reduce solid phase surface energy(3). Dopant addition also can reduce contact angle, avoid grain growth and disperse ceramic phase uniformly(8).

II. METHODOLOGY

Experiment procedure:

1. Cut aluminium in size of 2x2x1 cm (11 gram) then measure its weight.
2. Measure the weight of alumina and magnesium.
3. Compactive process

Compactive is a process of compression of powder material by adding some binder agent so the green compact obtain sufficient strength and can fracture easily. Alumina and magnesium powders mixed then added the binder as full hydrolyzed PVA.

The process of compactive is conducted by single action Hydraulic Pressing Machine, with load as high as 50 bar (5 Mpa). A dies od 2 cm in diameter is lubricated by Zn-Stearat before compactive process. The prepared and compacted raw material then arranged in a tray with the step as follows:

1. Make barriers in the tray according to the size.
2. Arrange the raw material according to lowest position i.e. aluminium ingot section then compacted alumina and magnesium mixture.
3. Cover remain upper cavities on the barrier by used alumina then put the tray into the furnace.
4. Conduct sinter process by programming the carbolite furnace with parameters of sinter temperature of 1300 °C and temperature rate of 200 °C/hour and holding time of 15 hours.
5. The sample then is cooled in the furnace until it reach room temperature
6. Uncover the barrier to take the sample out

III. RESULTS AND DISCUSSION

A. Effect of Magnesium on Hardness

The composite hardness is going lower by increasing magnesium percentage. The reduce of hardness value is obtained when Mg percentage of 14%. Addition of 10% magnesium shows increasing in hardness with the maximum hardness value of 530 BHN. Higher hardness show the formation of strong atom bound(9). This increasing followed with reducing hardness value is caused by porosity factor and phase exist in the composite. Hardness of pre-form compaction composite is higher compared to release powders.