

## Reinforced Green Ceramic Shell Mould for Investment Casting Process

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### Abstract

Basically in the investment casting process development of thin ceramic shell mould is very crucial as this mould inherent brittle property and highly exposed to the cracking mechanism. The slurry composition produces green(unfired) ceramic shell mould which low in strength and easily crack or fail during wax removal or handling processing. By strengthening of this brittle ceramic shell mould via reinforcement technique can enhance the strength of green shell mould body. In this work, the presence of the treated rice husk fibre toughened the green shell mould by creating mechanical interlocking bonding in shell matrix which contributes to higher modulus rupture value. In fact, through SEM observations showed that the addition of fibers to the ceramic body to form a composite shell mould prevent the crack propagation mechanism due to the existence of the matrix-fibre bridging which create the resistance of fiber to pull-out. This directly will increase the strength of green shell mould body.

**Keywords:** Rice husk ash, zeolite Y, hydrothermal.

### Introduction

The development of a very thin ceramic shell mould is very complex as it involves several dipping process in slurries which composed of fine mesh refractory filler system and a colloidal binder system[1-2]. The process is followed by the drying and firing stages to consolidate its brittle

structure[3]. Generally, ceramic shell mould exhibits extreme brittleness and is highly susceptible to fracture as it originated from colloidal slurry loose particles. This ceramic slurry produces ceramic mould with very low green strengths and is always associated with the casting defects [1-4]. The strength and integrity of the mould are very important factors in ensuring that the metal part has the proper dimensions. Indeed, ceramic shell moulds must exhibit higher green strength to prevent defects in shell making process. Green ceramic shell strength was found to be mostly independent and influenced by the refractory particles bonded with air dried colloidal silica. In addition, both wax and ceramic will expand during dewaxing heating and as a consequence, the weak unfired ceramic shell is prone to cracking mechanism[4]. Therefore, the green strength of shell mould is not strong enough to ensure minimal breakage during the shell making operation at early stages and also during the dewaxing process. Rice husk fiber is one of the reinforcing material that can be used in ceramic shell mould system. In fact, this organic fiber also known as biodegradable material which is also a non hazardous element. These fibres are designed to act as a composite reinforcing agent that will increase the green strength to prevent cracking within the ceramic structure during autoclave wax removal [1-2]. Indeed, the treatment of rice husk fibres also can enhanced ceramic green strength due to coarse and rough surface that bind the loose ceramic particles in this brittle structure of the green shell mould system

### Experimental method

Prior to the reinforcement technique, in this work the rice husk fibre are treated using NaOH solutions based on the previous work. Three samples were prepared via dipping into slurry with rice husk treated, rice husk without treatment and standard sample without additive. Scanning Electron Microscopy (SEM) was used to examine and observe the break specimen in green body of shell mould system.

### Results & discussion

The morphology of brittle fracture surface of green shell mould without reinforcement or rice husk fiber is shown in Fig. 1, indicates the surface of green non reinforced shell mould can be easily cracked and fail under the brittle mode with low energy absorption[19].

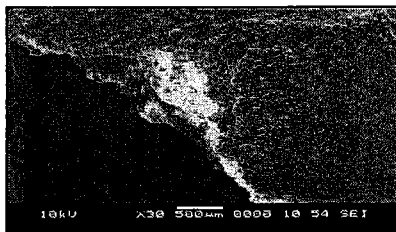


Fig. 1: Morphology of brittle fracture surface of green non reinforced shell mould

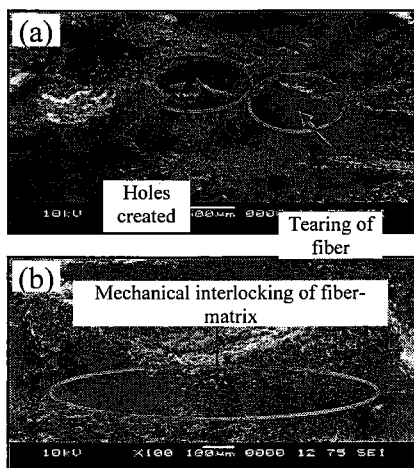


Fig 2 : Fracture surface for shell mould with untreated(a) and treated rice husk fibers(b) Both fractures show the mechanisms of fiber pull out from the shell mould matrix that contributes to the resistance in

fracturing the shell. As can be seen in Fig. 2 (a), the treatment process tends to create the adhesion mechanism via its roughness surface due to the interlocking mechanism (as shown in Fig. 2 (b)) that consequently increased the resistance in the fracturing process. However, the smooth surface possessed by the untreated rice husk surface has directly reduced the fracturing strength in shell system.

### Conclusion.

Fibre reinforced in green shell mould system by rice husk fibres has proved increased the green shell strength which benefited to the shell making process by preventing cracking mechanism due to lower green strength and excessive shrinkage during drying stage. Improvement of these mechanical and physical properties of the ceramic shell will definitely improve current casting quality and reduces manufacturing costs.

### References

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