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Araştırma Makalesi / Research Article

Tarımsal Atık Takviyeli Kompozitler: Sürdürülebilir Bir Çevre İçin Bir Çözüm

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Özet

Tarımsal atıklar veya tarımsal atıklar, çiğ tarım ürünleri yetiştirildiğinde ve işlendiğinde elde edilen artıklardır. Tarım ürünleri sebze, meyve, et, mahsul, kümes hayvanları ve süt ürünlerini içermektedir. Her yıl ortaya çıkan tarımsal atıkları tahmin etmek zor ancak kuşkusuz tarımsal atık, tüm dünyada üretilen toplam atık maddesinin önemli bir bölümünü oluşturmaktadır. Bu makale, büyük miktarda tarımsal atık miktarını ve yeni kompozit malzemelerin ve diğer uygulamaların sentezlenmesinde rasyonel bir şekilde faydalanarak etkin bir şekilde nasıl yönetilebileceğini incelemektedir. Sadece bu büyük miktardaki tarımsal atığın elden çıkarılması sorununu çözmez, aynı zamanda sürdürülebilir çevre için bir çözüm sunar. Tarımdaki herhangi bir gelişmeye, daima farklı tarım yöntemleri ve işleme teknikleri tarafından üretilen atıklar eşlik eder. Tarımsal atıklar ekimde kimyasalların yaygın olarak kullanılması ve tarımsal atıkların yakılması veya toprağın doldurulmasıyla irrasyonel bertarafı nedeniyle de kullanılır. Çevreyi ve toprağın verimliliğini kötü etkiler. Bu yazıda ayrıca, daha güçlü, daha hafif ve düşük maliyetli olan ve çeşitli endüstriyel uygulamalar için kullanılabilen, matriks olarak Alüminyum ile metal matriksinin kompozit haline getirilmesinde takviye malzemesi olarak bir tarımsal atık Pirinç kabuğunun uygulanması anlatılmaktadır. Kompozitler karıştırma teknikleriyle sentezlenir ve yapısal özellikleri için XRD, SEM ve optik mikroskopi ile karakterize edilir. Pirinç Kabuğu Külü, takviye malzemesi olarak ağırlıkça% 3'lük Alüminyum metalinden alınmıştır. Sertlik, Young modülü gibi mekanik özellikler de Vicker'ın Sertlik test cihazı kullanılarak değerlendirilmiştir.

Anahtar kelimeler
Tarımsal atık; Princ Kabuğu; Metal Matrils Kompozit; Karıştırma döküm tekniği; XRD; SEM

Agro Waste Reinforced Composites: A Solution For Sustainable Environment

Abstract

Agro- wastes or agricultural wastes are the residuals obtained when raw agriculture products are grown and processed. The agriculture products include vegetable, fruits, , meat, crops, poultry and dairy products. Its difficult to estimate the agriculture waste arising every year but undoubtedly agro waste constitutes a significant volume of the total waste matter generated in the entire world. This article reviews the huge amount of agro waste and how it can be managed effectively by making rational use in synthesizing novel composite materials and other application. It not only solves the major problem of disposal of this huge amount of agro-waste but also offers a solution for sustainable environment. Any development in agricultural is always accompanied by wastes generated by different farming methods and processing techniques. Agro waste is also generated because of extensive use of chemicals in cultivation and irrational disposal of agro waste by burning or land filling. It badly affects the environment and the fertility of the soil. This paper also describes the application of an agro –waste Rice husk as reinforcement material in making metal matrix composite with Aluminium as matrix which is stronger, lighter and low cost and can be used for various industrial applications. The composites are synthesized by stir cast techniques and characterized by XRD, SEM and optical microscopy for their structural properties. The Rice Husk Ash was taken as 3% wt of the Aluminium metal as reinforcement material. The mechanical properties like Hardness, Young's modulus etc are also evaluated using Vicker's Hardness tester.

Keywords
Agrowaste; Rice husk; Metal matrix composites; Stir cast technique; XRD; SEM.

1.Introduction

Agro- wastes or agricultural wastes are the residuals obtained when raw agriculture products are grown and processed . The agriculture products include vegetable, fruits, , meat, crops, poultry and dairy products (Obi et al.2016). Agro-waste includes animal waste (manure, animal carcasses), food processing waste for example only 20% of maize is canned while 80% is discarded as waste, crop waste such as corn stalks, sugarcane bagasse etc and toxic agricultural waste which includes insecticides, pesticides, and herbicides, etc. According to a research study it is estimated that about 998 million tonnes of agricultural waste is produced annually (Agamuthu 2009).

Agro-wastes which are the by-products ofagricultural produce, can be husk, straw, cobs or fiber (Abubakar and Ahmad 2010, Zurina et al.2004).Various agricultural activities generate waste such as cultivation, livestock production, aquaculture etc. The agro waste materials can be managed properly using 3R principle of Agriculture Waste Management System. “3Rs” stands for Reduce, Reuse and Recycle of the waste. These wastes can be transformed into useful materials for human and agricultural usage. With the huge amount of waste being produced, it has become essential to take necessary steps to save environment from further damage by unthoughtful disposal of such waste.

The agro – wastes are generated by any of the following activities:

- Wastes from Cultivation Activities
- Wastes from Livestock Production
- Waste utilization routes
- Fertilizer Application
- Anaerobic Digestion
- Adsorbents in the Elimination of Heavy Metals
- Pyrolysis
- Animal feed
- Direct combustion

Almost 52.5% of the agro waste materials are used as land fillings , 25.8% are recycled, 8.9 are used for composting and 12.8% are used for combustion process. However, Agro-wastes can be used for the production of Biogas, bio fertilizer, extraction of various minerals etc. Some more applications of agro wastes are as mentioned below:

- Rice Husk Ash - As reinforcement material Additive in cement mixes, Water glass manufacture, Active carbon, synthesis of composite materials
- Banana Peel & Sugarcane fibers –In making Paper pulp
- Onion skin, Groundnut husk – To remove heavy metals
- Husk, Straw, Cow Dung – Biogas production, Electricity generation
- Animal waste(dung) – Compost, fertilizer

Use of Agro – waste as fillers in Composite Materials

With the advancement in technology, there is a huge demand for novel materials with improved and customised properties which are not offered by traditional materials. Material scientists are researching for new materials and processing techniques of hybrid and composite materials which are stronger, lighter and with so many other properties and are highly functional (Laad and Jatti, 2015) Composites materials comprise of two or more types of materials with different properties and the properties of the composite material is superior to the properties of constituent materias. The composites with agro waste and natural fibers exhibit improved water and oxygen barrier, enhanced mechanical strength,

better dimensional stability, higher thermal, chemical and wear resistance etc (Ates et al. 2008). In industrial applications, agro waste fiber reinforced thermoplastic composites are very popular construction and automobile industries, and other consumer applications because of their improved properties and low cost (Dominiqueet al. 2012, Panthapulakkal 2005). A research study has shown that underutilized agro-waste are significant resources of lignocelluloses materials, such as millet, rice, wheat, corn straw, cocoa husk, corncobs and fiber (Tsai et al. 1998, Wang and Sun 2002, Yang et al., 2006). Natural fibres, such as hemp, flax, jute and kenaf have good strength and stiffness, and much lighter in comparison with other reinforcement materials such as glass fibres.
The use of natural fibers in making composite materials grew rapidly specially in construction industry. The use of agro-waste for developing novel composite materials to be used for various industrial applications provides a solution which not only reduces the use of natural resources but also saves energy. In this research study the reinforcement material is rice husk ash which is added to the aluminium alloy matrix to synthesize a metal matrix composite.

Rice husk (RH) is a major source of silica, which is naturally available through agricultural by-product advocates the sustainable development. In most of the rice producing countries, the rice husk, which is obtained after the processing of rice is either burnt as fuel in the boilers or used in the landfills. (Laad et al. 2015) .Applicability of RH in metalworking will be contemporary, eco-friendly and will complement the industries. For the most part RH gets desolated by either dumping or burning, but recently many practices have emerged for its equitable applications. A technique, to utilise RH as reinforcement for Metal Matrix Composite was explored to obtain a hybrid material, which incorporated the preparation of RHA (Rice Husk Ash) and the stir casting method to attain the MMC. Aluminium was used as the base metal for the metal matrix which was melted and RHA was added along with Magnesium.

2. **Materialsand Methods**

The synthesis of Al-RHA requireed Aluminium alloy in powder form, Rice Husk Ash and Magnesium as wetting agent. The synthesis of metal matrix composite involved following steps.

2.1 Preparation of Rice Husk Ash (RHA)

The Rice husk was sieved using mesh size of 300 microns to remove the impurities like Rice particles, Rice plant particles. The Rice Husk was burned in an electrical furnace at 600 ^{0} C for 2 hours till all the organic, volatile material present in the Rice husk was burnt and the husk turned white in colour. The ash obtained was almost 20% of the total weight of the rice husk which was burnt in the furnace. Rice Husk Ash was then sieved using sieves of different mesh size. Different size of RHA was obtained, which were 180 microns, 110 microns, 90 microns, 45 microns. About 30% of the total RHA was of size 45 microns, 50% of 90 microns and 20% above 90 microns.

2.2 Preparation of Metal Matrix Composites reinforced with Rice husk ash

For synthesis of MMC with Aluminium as matrix metal, RHA was taken 3% wt and Magnesium powder 1.5 wt % of Aluminium alloy. Initially, Al alloy was charged into the graphite crucible and heated to about 750 ^{0}C till the entire alloy in the crucible was melted.The reinforcement particles (RHA) were preheated to 800^{0}C for 30 minutes before incorporation into the melt. As wetting agent 1.5 wt % magnesium was also added to the melt simultaneously. A stirrer was used to stir the molten metal at a speed of 500 -700 rpm for uniform distribution of rice husk ash in the moltem metal. The preheated RHA particles were added into the molten metal at a constant rate during the stirring time. The mixture was poured into the mould uniform solidification. Using this process 3% RHA particle-reinforced composites were produced. The Vicker's Hardness tests were performed on the Aluminium and on the composite to evaluate the mechanical properties and results were compared. The composite sample were subjected to Optical microscopy, SEM and

XRD to know the composition and structural properties.

3 Results and Discussion

3.1 Hardness Measurement

Vickers hardness tester was used to measure the hardness of Al-RHA composite. A significant increase in hardness of the alloy matrix was seen with addition of RHA. It suggests that the presence of RHA in the aluminium alloy matrix improved the overall hardness of the composite material. It can be concluded that the presence of stiffer and harder RHA as filler material is responsible for the increase in resistance to plastic deformation of the matrix. The hardness of Aluminium alloy was measured to be 23.17 VHN which increased to 26.93 VHN when reinforced with rice husk ash. Young's modulus also found to be improved from 137.315 MPa to 151.493 MPa

3.2 XRD Measurement

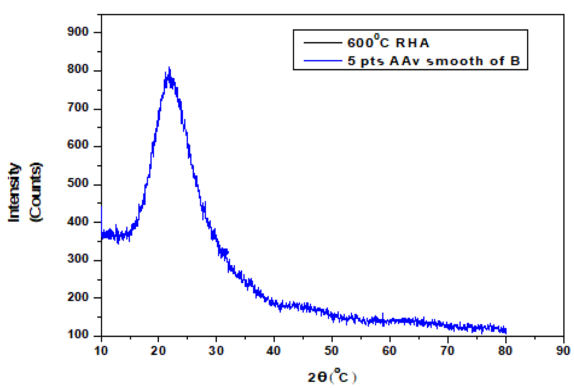

Figure 1. The Al-RHA composite of XRD peaks.

The major constituent of RHA is silica. It was observed that the crystallinity of silica in RHA depends upon incineration temperature. As per the XRD spectroscopy at 600^0C, it shows the amorphous character of silica in RHA. Its due to the fact that at temperature 600^0 C, the ash obtained had some residual half burnt carbonious material. When rice husk is burnt in the furnace, the volatile matter such as lignin, cellulose, hemicelluloses do not burn completely at this lower temperature. That's the prime reseason for the amorphous character of Rice husk when insinerated at lower temperatures. The brittle behaviour of RHA can be attributed to its glass like amorphous structure.

3.3 Surface Morphology & Micro structural Study of RHA using SEM

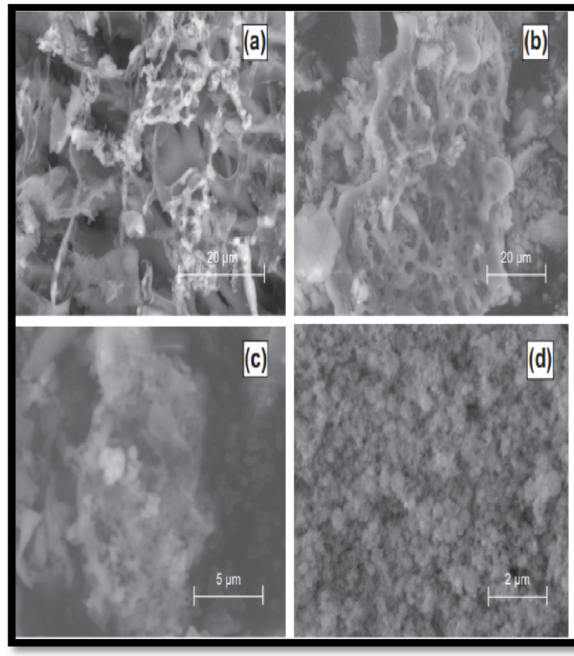

Figure 2. Micro structural Study of RHA using SEM

SEM image of RHA shows the presence of irregular, sharp edges with angular and cuboidal shaped particles with size varying from 5 micrometer to 10 micrometer. It has highly porous structure with homogeneous particle distribution. The presence of micron size particles is also observed together with some other bigger particles.

3.4 Optical Microscopy

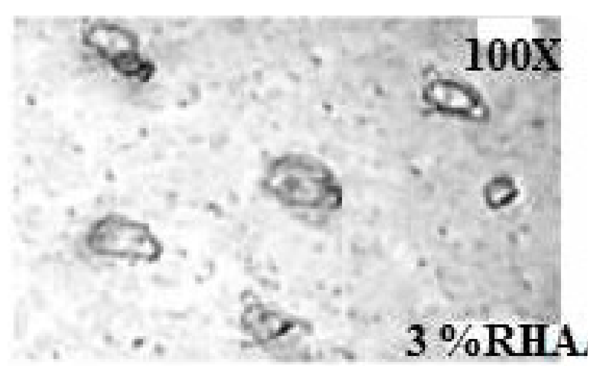

Figure 3. Micro structural Study of RHA using Optical Microscopy

Above figure shows the optical micrograph of Al-RHA composite. It shows that RHA is uniformly distributed in the Al alloy matrix.

4. Conclusion

The rate and volume with which the contribution of agro waste is growing in the total waste matter of the world, its alarming situation which calls for serious thought on the rational waste management techniques and use of agro waste in the best possible manner which will constructively help the human kind and animals and also save the environment. The agro-waste rice husk which is abundantly available in all the rice producing countries is successfully used for extraction of rice husk ash and lighter and stronger Aluminium alloy-RHA composites were synthesized which were characterized for their composition, structural and mechanical properties using various techniques. The hardness of Al alloy –RHA composite was found to be increased in comparison with that of unreinforced Al alloy. Also it was revealed that RHA reinforced composites had higher hardness value and lesser in density compared to Al alloywhich indicates that the composite reinforced with RHA is lighter than the aluminium alloy. Thus the Al alloy-RHA composites have improved mechanical and structural properties and may find applications in automobile, aerospace,construction and biomedical industries where materials with increased mechanical strength but lighter in weight are much in demand. Moreover, due to partial replacement of the expensive metal alloy with RHA the cost of the composite will also be significantly reduced. Thus, RHA can not only be used as reinforcement material in the fabrication of lighter, low cost and high performance MMCs but also it will solve the problem of disposal of this abundantly available agro waste and save the environment. This study paves the way for finding suitable applications of all the available agro- waste and save our environment.

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