Preparation ultra fine particles from Ceramic refractory material using CO_2 Laser

Tarik Talib Issa, **Talib Khalil Ibrahim***
Department of Physics, College of Science, University of Baghdad, Jadiriya, Baghdad, Iraq
* Minstery of science and Technology, Physics department

Abstract

Samples of compact magnesia and alumina were evaporated using CO_2-laser .The

Processed powders were characterized by electron microscopy and both scanning and transmission electron microscope. The results indicated that the particle size for both powders have reduced largely to 0.003 nm and 0.07 nm for MgO and Al_2O_3, with increasing in shape sphericity.

Keywords
Cadmium sulphide
Hetrojunction

Article info
Received: June. 2009
Accepted: Sep. 2009
Published: Dec. 2009

تحضبر مساحيق فائقة النعومه من مواد سيراميكيه صناعيه باستعمال تقانة ليزر ثاني اوكسيد الكاربون

طارق طالب عيسى, طالب خليل ابراهيم*
قسم الفيزياء - كلية العلوم - جامعة بغداد – الجادرية – بغداد - العراق
* وزارة العلوم والتكنلوجيا – الجادرية – بغداد - العراق

الخلاصة

حضرت مساحيق فائقة النعومه لمكبوسات المواد السيراميكيه ,اوكسيد المغنيسيوم واوكسيد الالمنيوم , حضرت باستعمال تقانة ليزر ثاني اوكسيد الكاربون . درست خصائصها التركيبيه بواسطة الحيود الالكتروني والمجهر الالكتروني الماسح والنافذ. النتائج بينت الاختزال بمقدار الحجم الحبيبي للمساحيق المحضره بحيث اصبحت بمقدار 0.003 نانو متر لمسحوق اوكسيد المغنيسيوم و لاوكسيد الالمنيوم0.07 , مع زياده في شكل الكرويه للحبيبات

Introduction

The standard methods of making powders involve grinding, wet chemistry and solid- state (1) reactions, which have shortcoming, such as contamination, particle agglomeration, and high energy consumption. In addition the particles produced vary in size when they are packed together and sintered, some of the spaces among them are filled in by particle rearrangement and mass transport processes ; but voids usually remain . Laser is used in many applications, i.e. in the laboratory, in industry, and in medicine. The ideal heat source proved to process involves blowing the reaction gases through the beam of a Co_2 – laser to increase the reliability and decrease the resulting porosity which acts as elements of incipient cracks. At which the ceramic could break. Researchers (2) tried to minimize the porosity before sintering using spherical particles all of one size packed in a regular manner.

Experimental work

Two types of ceramic powders were used, MgO and Al_2O_3 of 75um grain size. Discs of 15mm diameter and 3mm thickness were unixailly pressed under 3 tons force. The schematic of equipment shown in figure (1), making powders from laser heated gas. The laser beam of diameter 20mm which reflect inside the evaporation chamber by zinc- Slenoed lens of 50 mm focal length, the typical pressure of He – Ne used is (10-20) mbar, with power of 45(w).

The producing powders about 5mgm/min, and was tested by – x-ray diffraction to identify the crystal structure. Both scanning and transmission electron microscopes were used to determine both the size and the shape of the grains (sphericity).

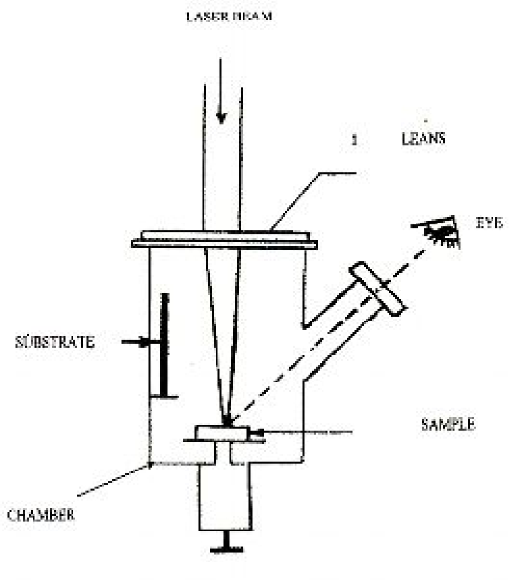

Figure (1): Experimental arrangement for ceramics powder processing using CO2-laser.

Results and discussion

The produced powders generated by laser having either crystalline or amorphous crystal structure, with highly reduced in its grain size and increased shape sphericity. The resulting data for MgO grain size reduced from (00095 – 0.0003) nm with crystalline form as shown in figure (2).

While for Al2O3 the grain size reduced from (134.77-7) nm, whith amorphous crystalain form as show in figure (3) .This is because of the rapid cooling rates leading to quench forming the amorphous structure (3).And due to laser heating which insure the formation of nucleation for all particles grain with same size (4), followed by quickly cooling, so particles that collide due to Brownim motion do not sinter to form agglomerates.

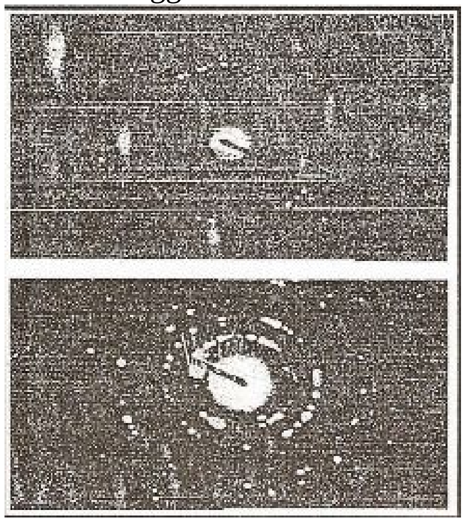

Figure (2):Electron diffraction of MgO powder after laser processing.

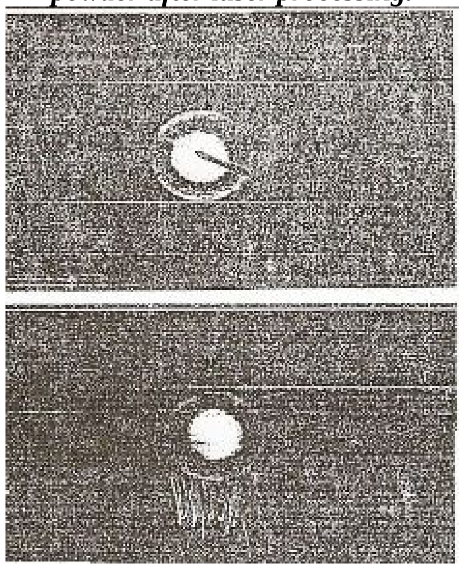

Figure (3):Electron diffraction of Al2O3 powder after laser processing.

Conclusions

1. Because the laser is turned to the absorption wave length of the reactants, it does not heat the container walls or other foreign substances , making the process energy efficient and producing high – purity material.
2. The reactant of Co_2 – laser beam with the material to produce the ultra fine grains is controlled with constant power and low cost, comparing it with the conventional grinding techniques.
3. The produced powders was of ultra fine grain size with high sphercity .
4. law producing rate for about 5 mgm/min .
5. The production rate depends on the power of Co_2 – laser and the best optimum focusing conditions.

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