Synthesis of Nanoparticles of Aluminum –Boron complex by DC-transferred Arc Thermal Plasma.

[1]Prof.Monika V. Jagtap
[1] Assistant Professor
First Year Engg. Dept.
ABMSP's Anantrao Pawar College of Engg. & Research.
Parvati, Pune 411009,India

Abstract: In this article, Aluminium Boride based nanoparticles are prepared by DC-direct transferred arc thermal plasma method. The structural characterization revealed the growth of amorphous nanoparticles. It is observed that particles are spherical and the particle size varied in the range of 10nm to 80nm.Therefore the synthesis of Al-B complex is possible by DC- transferred arc plasma.

I.Introduction

Semiconductor nanoparticles have attracted great applied during the past two decades. New devices with semiconductor nanoparticles may possess novel optical and electronic properties, which are potentially useful for technological applications, compared to the corresponding bulk material [1].

Extremely high surface area to volume ratio is obtained with the decrease of particle size, which leads to an increase in surface specific active sites for chemical reactions and photon absorptions. The enhanced surface area also affects chemical reaction dynamics. The size quantization increases the energy band gap between the conduction band electrons and valence band holes which leads to change in their optical properties [2]. Aluminium boride is a very good luminescent material used in displays, ultraviolet and visible lasers, solar cells components, gas sensors. There are various methods of preparing nanoparticle like boll milling, sol-gel, RF-thermal plasma [3].

The DC-transferred arc thermal plasma method was used to synthesize aluminium boride based nanoparticles. The DC-transferred arc thermal plasma has been received great attention as a useful method to synthesize nanoparticle. Since a substance is easily evaporated in large volume of thermal plasma. A pure aluminium and boron powders were used as the row material in this work. The composition of raw material was controlled at 1:12. Raw materials were mixed uniformly given composition, and then the powder mixture was put into the DC thermal plasma by a graphite crucible. Argon 3L/min was used as a carrier gas for the evaporation of raw powder mixture.

II. Experimental

Nanoparticles of Al-B were synthesized by DC- transferred arc thermal plasma method. Pure aluminium and boron powders, mixed in required proportion, were used as initial ingredients. These ingredients were mixed uniformly, shaped into pellets and were kept onto the water cooled graphite electrode. Commercially available argon was made to flow through the plasma torch with the flow rate of 3L/min as a plasma forming gas for the evaporation of aluminum-boron mixed powder. In addition Ar was purged through the side port having flow rate of 5 L/min. The operating pressure inside the plasma reactor was maintained at 350 torr throughout the experiment. The plasma torch was operated at 3 kW DC power and was impinged onto aluminum-boron mixture for 3 -4 min to evaporate it from the anode. The evaporated powder was collected from the inner wall of the water cooled chamber. The powder so obtained was characterized by XRD using Bruker D8 advance X-ray Diffractometer, EDAX by SEM – JEOL JSM-6360A and TEM using TECHAI $G^2$20-TWIN (FEI, NETHERANDS).

III. Results and discussion:

Fig.(1) shows the XRD pattern for Al-B complex nanophosphors. From XRD patterns four diffraction peaks were observed at 14.27^0, 27.54^0, 39.74^0 and 66.37^0. From the XRD pattern and by comparing with the JCPDS data it is observed that the complex consists of B_2O_3 (marked with '*') and less crystalline structure of $AlB_{12}C_2$ (marked with 'o') with peaks at 34.27^0, 37.25^0 and 62.62^0. Figure 1 shows XRD pattern of product synthesised in the Al-B system. The XRD pattern shows the amorphous structure of the material.

The nature of crystalinity was consistent for repeated synthesis, carried out at identical conditions.

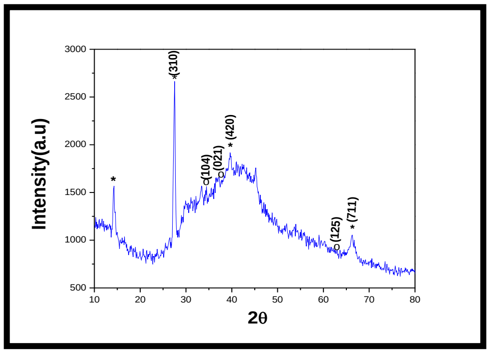

Fig.(1) XRD pattern of amorphous Al-B complex nanoparticles

Fig.(2) shows the EDAX spectra of aluminium boron based composites which suggests presence of aluminium, boron and carbon.

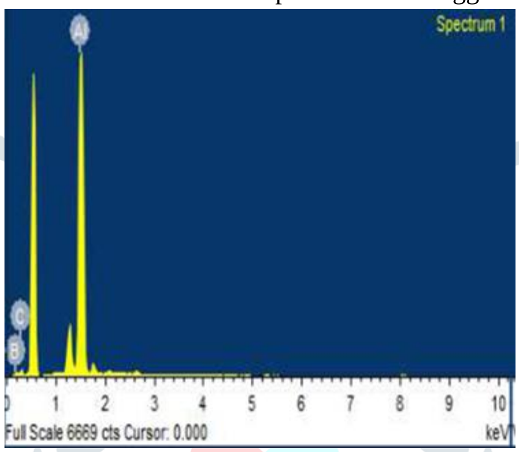

Fig.(2) EDS spectra of Al-B complex nanoparticles

Fig.(3) shows the TEM image of the as synthesized nanoparticles of Al-B complex. It shows that the particles are spherical and the particle size varied in the range of 10nm to 80nm. The inset shows histogram of particles size. It is seen from Fig.4 that maximum number of particles possesses size in the range of 20 – 30 nm.

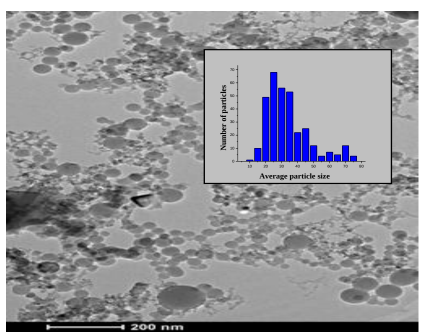

Fig.(3) TEM image of Al-B complex nanoparticles.

IV. Conclusions

In conclusion, a DC- transferred arc plasma technique is successfully used to synthesize Al-B complex by pure aluminium and boron powder. The XRD pattern synthesized complex powder shows the amorphous structure of the material. The nature of crystalinity was consistent for repeated synthesis, carried out at identical conditions. Synthesizednanoparticles of Al-B complex. It is also observed that the particles are spherical and the particle size varied in the range of 10nm to 80nm and maximum number of particles possesses size in the range of 20 – 30 nm.

V.References

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