Jour. Geol. Soc. India (2022) 98:1328
https://doi.org/10.1007/s12594-022-2173-0

NEWS AND NOTES

Value Addition to Low-grade Coal Resources: A New Avenue for its Alternative Utilization

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Received: 9 June 2022 / Revised form Accepted: 15 June 2022

Introduction

The Tertiary coals of Northeast (NE) India has been regarded as low-grade/rank due to their high-sulfur content and presence of some undesirable properties such as having low ash fusion temperature, and high volatile matter, etc. There is a growing importance of utilization of such coal feedstock, because of the sharp fall in the reserve-to-production ratios of high-grade coal. In our research group at CSIR-NEIST, we have been carrying out extensive research to find out the alternative utilization of NE coals for their gainful and sustainable utilization. We have discovered the presence of short-range structural aromatic domains of carbon in Tertiary Indian sub-bituminous coals (Boruah et al., 2008). We aimed to synthesize high impact carbon quantum dots (CQDs) from these coals by adopting simple, less expensive, and eco-friendly chemical processes (Fig.1). Carbon quantum dots (CQDs) are typical nanocarbon with size less than 10 nm and have emerged as an intensive research activity due to their broad range of application in extraordinary fields of bio-imaging, biosensing, photocatalysis, photovoltaic devices, and opto-electronics.

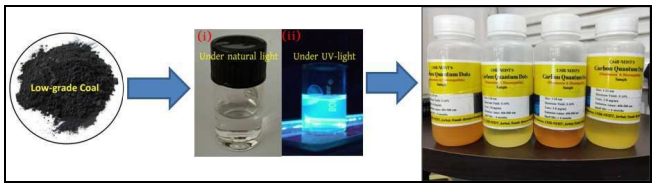

Fig.1. Schematic diagram of synthesis of blue-fluorescent carbon quantum dots (CQDs) from NE high sulfur coal

In our process, twelve (12) g of NE coal sample was mixed with hydrogen peroxide (20-30%) in an ice-cold condition. The reaction mixture was then ultrasonicated (frequency: 20-40kz) in a microprocessor-based ultrasonicator for about 5-6 hrs at an atmospheric pressure and temperature. The resultant mixture was then cooled to room temperature and followed by the neutralization (Saikia et al., 2020). Then, CQDs are finally obtained by ultrafiltration followed by dialysis technique (Fig.2).

The synthesized non-toxic CQDs was successfully used as a fluorescence contrast agent for cell-imaging (Das et al. 2019). It was also observed that the coal-derived CQDs can be used as a carrier of nutrients and microbes for plant growth promoter and has potential to act as nanofertilizer (Saikia et al. 2022).

Table 1. Properties of some NE raw coal samples (wt %) (Das et al. 2019)

Sample	Proximate Analysis (%)			Ultimate Analysis (%)			TS (%)
	M	Ash	VM	FC	C	H	
TD-T60	2.20	2.95	45.02	49.82	80.40	5.97	3.62
TD-T20	2.35	2.33	50.27	45.05	80.90	8.19	1.90
TD-NK	3.82	19.04	36.32	40.83	61.20	5.86	3.26
TD-NG	9.11	4.44	49.07	37.38	67.50	7.31	3.59

M-Moisture; Ash-Ash content; VM-Volatile Matter; FC-Fixed Carbon; C-Carbon; H- Hydrogen; N-Nitrogen; TS-Total Sulfur

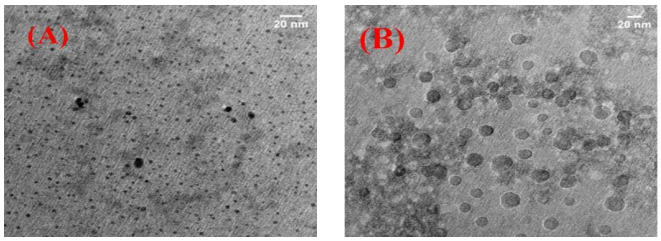

Fig.2. High-resolution transmission electron microscopy (HRTEM) images showing the homogeneous distribution of coal-derived CQDs which are spherical in shape.

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