Communication

Laser-Induced Fluorescence Spectra of Some High-Sulphur Assam Coals, India

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Introduction

Coal is a carbonaceous material of sedimentary origin, which occurs as an intimate mixture of complex organic mass and inorganic matter. The product of partial decomposition of living materials laid down in sediments on death makes coal very complex. The use of laser radiation as an excitation source has a major impact on the study of the complex material, such as coal.[1–5] A powerful coherent monochromatic laser source can serve a variety of applications, including sample-induced fluorescence. Thus, laser-induced fluorescence (LIF) provides, much as does Fourier transform infrared (FTIR) spectroscopy, fingerprints of different organic molecules, which can be quantified by measuring fluorescence intensities.

Many workers have described the microscopic fluorescence characteristics of various types of macerals.[6–10] Vitrinite, liptinite, and resinite are the most common fluorescing materials. Liptinite (much brighter than others) maceral fluoresce more brightly then vitrinites, which in turn fluoresce more brightly the inertinites. The fluorescence intensities depend upon the types of macerals, rank, and the degree of biochemical degradation in the peat swamp.

This communication is mainly concerned with the first preliminary qualitative interpretation of the fluorescence spectra exhibited by some high-sulphur coal samples from Assam with the application of an argon ion laser (500 mW, all lines). These present findings have shown prime importance in fingerprinting the structure of coals.

Experimental Section

Four different coal samples were collected from Ledo, Tikak, Baragolai, and Tirap collieries of the Makum coalfield, Assam (latitudes 27° 13′−27° 23′ N and longitudes 95° 35′−96° 00′ E). A traditional Argon (Ar^+) ion laser with a total power of 500 mW was used to excite the fluorescence of the coal samples. The experimental setup of the laser mainly consists of a two-prism glass spectrograph of low resolution and a sample cell. The finely powdered sample was kept between two finely held glass plates in the sample cell. The optical path of the specimen thickness is 1 mm. The exiting radiation selected for the purpose is 515 nm. It is worthwhile to note that the laser light allowed to incident was observed. This arrangement is identical with the arrangement of stimulated Raman scattering. An exposure time of 5 min is allowed to photograph the fluorescence. Commercial-available color film is used to photograph the spectrum. The fluorescence spectra were recorded in the same methods and conditions for all four representative samples. The intensities of the fluorescence band were worked out with the help of the Scion Image software for Windows (version Alpha 4.0.3.2).

For the petrographic analysis, polished sections were made from the representative coal samples following the standard technique (Indian Standard 9127 and 1979). Petrographic study and identification of maceral types were done according to the standard procedures (International Committee for Coal and Organic Petrology 1971, 1973, and 1994 and Indian Standard 9127 and 1979) by a Leitz orthoplan microscope under both white and fluorescence light. The macerals were grouped following the International Committee for Coal and Organic Petrology (ICCP) classifications, and the volume precent of various macerals was calculated using a swift point counter.[11]

Results and Discussion

The four coal samples produced very similar laser fluorescence spectra. Figure 1 represents the spectra for Assam coal samples photographed on an ASCO two-prism spectrograph. The band in the spectra was observed as broad, extending from 6100 to 6300 Å, a very narrow range, which is observed to be characteristics of the Assam coal samples. This diffused band is mainly due to the presence of rich vitrinite portions in Assam

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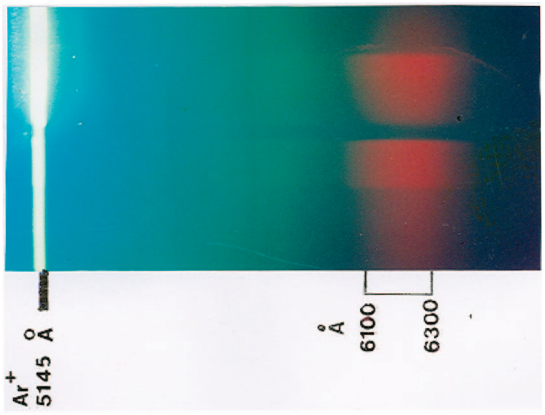

Figure 1. Representative fluorescence spectra of the Assam coal.

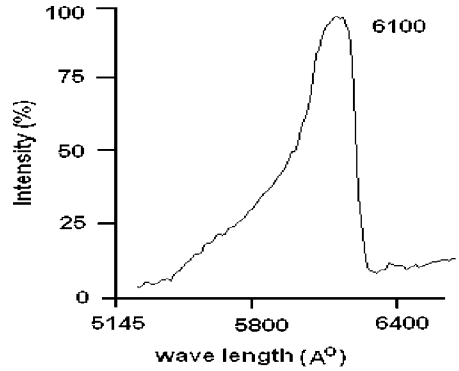

Figure 2. Plot of the wavelength versus LIF intensity.

coals. Figure 2 represents the plot for fluorescence intensities against the wavelength for the Assam coal. A maximum intensity was observed at 6100 Å, which is due to the vitrinite contents in the coal. Vitrinite fluoresce at a wavelength near 600 nm.[12] Many authors[13,14] have also reported this dark red fluorescence band for vitrinite in some coals. The vitrinite and liptinite group analysis of these Assam coals is shown in Table 1. The vitrinite contents of the four coals are observed to be approximately the same with a small range of 78.25–80.31 vol %, and liptinite are present in the range of 3.03–9.16 vol %. Vitrinites are derived from ligno cellulosic materials, which constitutes the woody cells and tissues in plants, making up roots, stems, leaves, etc. On the other hand, liptinites are composed of waxes and fatty acids that are rich in hydrogen contents. It is generally agreed that nitrogen in coal has come from plant and animal proteins and plant alkaloids.[15] Misra also reported the fluorescing vitrinite and liptinite macerals in northeast Indian coal to be 46.5–83.5% by volume (mmf).[16] The fluorescence displayed is due to the presence of fluorophores in coal, which are believed to be structures possessing a conjugated double-bond system, such as aromatics and polyenes with excitable mobile π electrons.[17] Coals are well-known to contain polycyclic aromatic compounds along with aliphatic chains.[18] This red band may also be due to the aliphatic group CH in the fluorophores. Scwartz et al. reported that oxidized coal fluoresced red, which is due to the presence of aliphatic hydrocarbons.[19]

Table 1. Physico-chemical Characteristic of the Coals (as Received wt %)

coals	ash	moisture	volatile matter	fixed carbon	total sulphur	vitrinite (vol %)	liptinite (vol %)
Ledo	10.35	3.07	43.38	43.20	3.57	78.65	3.20
Tikak	16.9	2.6	34.9	45.6	2.91	80.31	3.03
Tirap	6.6	1.8	45.4	46.2	3.20	79.88	8.16
Baragolai	5.7	2.4	47.4	44.5	5.30	78.25	7.17

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