

FTIR Spectroscopic Analysis on Marine Molluscan Shells

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ABSTRACT

The paper presents IR data on 4 species of marine molluscan shells collected from Vizag seashore. It is observed that irrespective of species, the mineralogical form of CaCO₃ is aragonite. This is due to the fact that Mg present in the shell material acts as a regulator for the deposition of CaCO₃. The paper suggests that infrared spectroscopy may be useful to provide valuable information in the biological system as it affords rapid qualitative and identification of biominerals.

Keywords: IR, Molluscan shells, aragonite and calcite

Information on inorganic composition in shells of invertebrates is essential as it helps in species characterization to some extent, and to understand the system (shell) as well as the environment in which these animals live.

Nakamoto^[1] made characterization of different types of CaCO₃ structures by IR spectroscopy as a result of the variation in crystalline arrangements of the carbonate ions. Ramaswamy *et al.*^[2] studied the mineralogical form of CaCO₃ deposition in some marine molluscan shells using IR spectroscopy. Carter^[3] reported that higher salinity causes higher calcite to aragonite ratio in mollusks.

Watabe^[4] reviewed crystal growth of CaCO₃ in invertebrates which covers a wide ground. So far, no attention is paid to determine the functional groups of CaCO₃ in marine shells. In view of this, the studies were made on infrared spectroscopy of shells.

MATERIALS AND METHODS

For the present investigation, 4 species of marine molluscan shells were collected from the seashore

of Vizag situated on eastern coastal line of Bay of Bengal. The shells were cleaned to remove foreign material and ground in an agate and mortar to get fine powder of grain size less than 100 mesh. Minimum grinding was made to avoid the possibility of mechanically induced conversion of aragonite to calcite. A small quantity of shell powder was mixed with potassium bromide in the ratio of 1:4 and pressed in a stainless steel die to produce a thin crystalline KBr wafer, containing a relatively high concentration of shell sample in the IR transparent KBr matrix. IR spectra of shell samples and also of pure aragonite synthetic CaCO₃ and calcite were taken using FTIR spectrometer of make *Bruker Optics* and model *Tensor 27*. The resolution was kept at 4 cm⁻¹ and scanning time was fixed at 38 Sec. A total number of 32 scans were carried out on each sample. The scanning range fixed from 4000 – 400 cm⁻¹ for each sample.

RESULTS AND DISCUSSION

It is known that the total system of shell formation comprises of four compartments (1) hemolymph, (2) body tissues, (3) the extrapallial fluid compartment

Table 1: IR data of molluscan shells collected from Vizag seashore

Sample Code	Scientific name	Characteristic bands (cm ⁻¹)							
MSV01	<i>Pirula</i> sp.	700	860	1080	1785	—	2520	—	3400
MSV02	<i>Nerita</i> sp.	700	860	1080	1780	—	2520	2920	3400
MSV03	<i>Strombus</i> sp.	700	856	1080	1785	—	2520	2920	3400
MSV04	<i>Cardium</i> sp.	700	860	1090	—	1810	2520	2960	3400
Aragonite	—	714	856	1086	1795	—	2520	2930	—
Calcite	—	714	876	—	1785	1805	2520	2880	—

between the mantle and inner shell surface and (4) the shell. Two epithelia limit the body compartments except for the shell. One epithelium covers the body surface and admits ions from the outer medium to hemolymph. The second, the outer mantle epithelium, transfers Ca, HCO₃ and other ions from hemolymph to extrapallial fluid compartment and secretes organic components into the compartment. It is the extrapallial fluid having inorganic and organic substances for shell deposition. Because the growth and assembly of crystals are closely integrated with secretion and alteration of organic matrix, both mineral and organic phases are to be considered.

The calcium carbonate crystallites are grown in the organic matrix of the shell. The architectural differentiation in poly-crystalline aggregates of CaCO₃ in shell is due to the morphological adaptation of the crystal caused by the crystal matrix interaction during the process of bio-mineralisation.

Table 1 shows that the IR spectra of the marine shells, studied in the present investigation, exhibit the peaks at 700, 714, 856, 1086 cm⁻¹ suggesting that the CaCO₃ present in the shell is in the form of aragonite and also the peaks at 1790, 2520, 2920 and 3400 cm⁻¹ reveal the functional groups such as CO₃, CH₃, C-H, N-H of organic compounds of the shell matrix.

The presence of certain trace elements in the tissues may play an important role in controlling the deposition and mineralogical form of biominerals in the matrix of organic fibers. For the mineralization in shell, magnesium present in traces favors the deposition as well as mineralogical structure as aragonite of calcium carbonate. The concentration of magnesium is more or less the same^[5] in the shells of the present investigation. Hence, the calcium carbonate deposition in all the shell is of the form of aragonite.

The present study suggests that infrared spectroscopy can be used to provide valuable information of biological system and affords rapid qualitative and quantitative identification and characterization of biominerals present in different biological systems.

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