# EXPLAINING THE FLAME STRUCTURE IN NON-NACREOUS PEARLS

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*Abstract*

The sheen displayed on nacreous pearls is due to the structure of stacked aragonite tablets in parallel superimposition. Non-nacreous pearls often show a flame structure that is due to a crosswise array of bundles of aragonite laths or fibres. Small domains of bundles alternate with their orientation. Light striking the length of the bundles is reflected, light falling on the section of the bundles is absorbed. By this behaviour brighter areas alternate with darker ones, producing the flame structure. This structure is typical of the porcellaneous lining of marine gastropod shells and some bivalves, and their pearls produced by the same mantle tissue. As they occasionally produce calcareous concretions, these may display the same structure.

*Introduction*

The intention of this short paper is to demonstrate the reason for the peculiar pattern seen on some porcellaneous (non-nacreous) pearls, commonly described as 'flame structure'. Some pink conch pearls exhibit this pattern quite clearly (Fig. 1). A comparison to the pearly nacre structure is also presented. The reason for both structures, nacre and flame, is to produce a shell with extraordinary mechanical resistance, copied in technical material such as laminated glass or fibre-glass. Previous reports on the structure of shell are found in a wide selection of publications on marine shells, and e.g. in the excellent book of Strack (2005) or Scarratt & Hänni (2004). For the naming of pearls with flame structure see the CIBJO Pearl Book.

Figure 1.
The flame structure clearly exhibited by a pink conch pearl, with brighter and darker areas, and other non-nacreous pearls. The structure is caused by small domains of bundles, adjacent bundles showing different orientations.

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*Texture of nacre*

Natural pearls are highly in demand today. The most appreciated ones are the nacreous pearls often called oriental pearls. Many textbooks and articles report on the build up of nacre, consisting of layers of sub-microscopic aragonite tablets, stacked over each other. The daily deposition rate is estimated at about 10 to 20 of these approximately 500 micron thick crystallites. Food availability, water temperature and salinity may influence the productivity of the mantle tissue involved. The display of such minute structural details, as seen in nacre, is possible with a scanning electron microscope SEM (Fig.1). Other techniques such as atomic force microscopy AFM are also effective in such surface analysis. The texture of nacre has been described in a large number of books and other publications (see selection of references below).

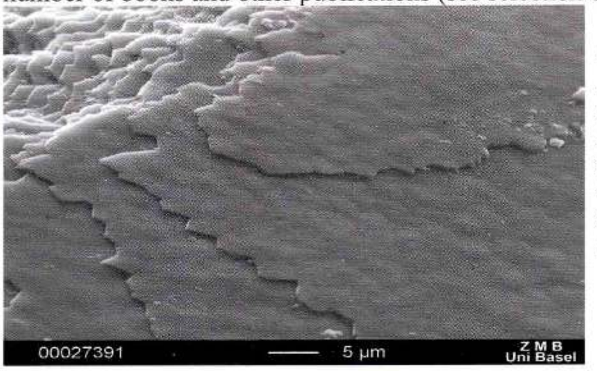


Figure 2

A Scanning Electron Microscope picture of a broken piece of nacre (Pinctada margaritifera) showing the surface and the stacked aragonite platelets of approximately 500nm thickness.

Picture © Henry Hänni

*Texture of shell and pearls with a flame structure*

A peculiar structure has been observed with shell material of some marine gastropods and bivalves. This consists of a pattern of brighter and darker areas, having a shape of alternating spindles or small bands to fan like forms, from 0.1 to 2 mm in length. Among species displaying these features are Melo, Strombus, Cassis and Tridacna. A polished section through a piece of shell of Strombus gigas is shown in Fig. 3.

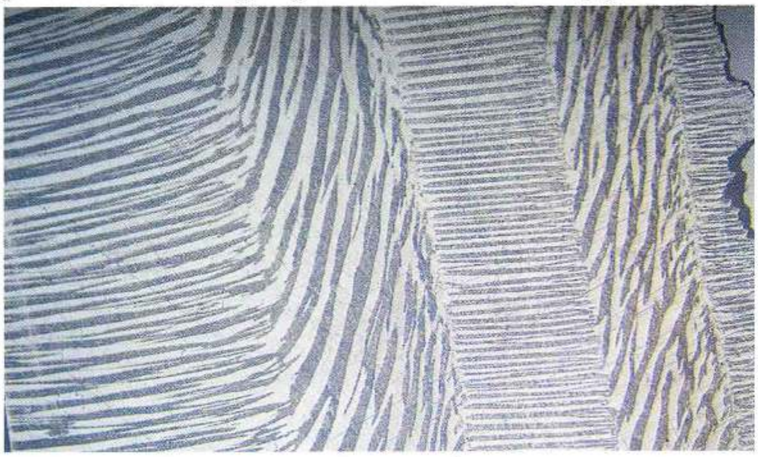

Figure 3

A polished section through a piece of pink conch shell in reflected light. Spindle shaped areas alternate in bright and dark bands.

Width of the picture is 5mm.

Photo © H. A. Hänni SSEF

The typical flame structure on the surface of a Caribbean pink conch pearl has a similar appearance. Cameos cut from Cassis shell also display such a structure in the orange part of the shell. In order to investigate the reason for this banded structure, material from a Strombus shell and from a Tridacna shell were broken and small fragments were analysed with a SEM. The shape of the constituent aragonite crystals and its array became visible. The material consists of fibres and lath-shaped crystals in specific crosswise orientation (Fig. 4).

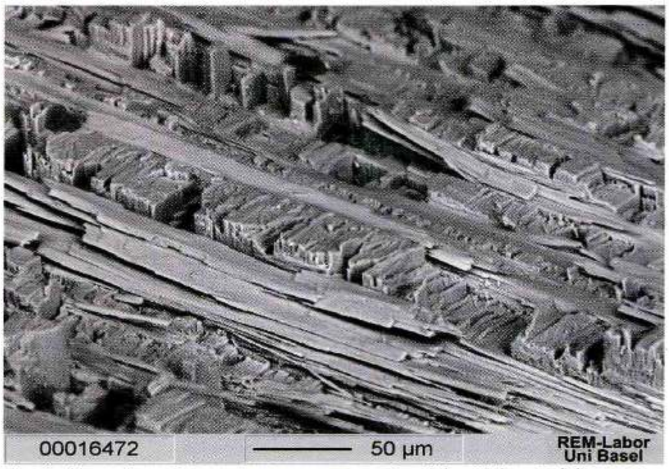


Figure 4

Scanning Electron Microscope picture of a broken surface of Strombus gigas (pink conch pearl) showing an almost perpendicular orientation of arrays. The laths consist or aragonite and form in layers.

Picture
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A similar situation was encountered with white Tridacna pearls that often show a fine flame structure. Since no pearl was available to crush and investigate the broken surface, a Tridacna shell was kindly provided by the local museum for natural history. Fine lines are seen with a 10x lens on the inner surface of the shell that can be described as flame structure (Fig. 4). With a strong fibre optic light and a microscope the lines may even display interference colours, which gives an indication of the thickness of the structures involved.

Figure 5

A pattern of reflecting bright spindles alternating with dull spindles on the inner surface of a Tridacna shell. The bright spindles display interference colours.

Width of the image is 4mm.

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Under the scanning electron microscope the same bright and dull bands are visible, but the higher magnification allows a better resolution of the structure (Fig. 6). Stacked piles of aragonite lamellae in crisscross position form the material. Those lamellae that stand in a reflection position to the light are bright, those in the opposite position conduct the light away and are dull.

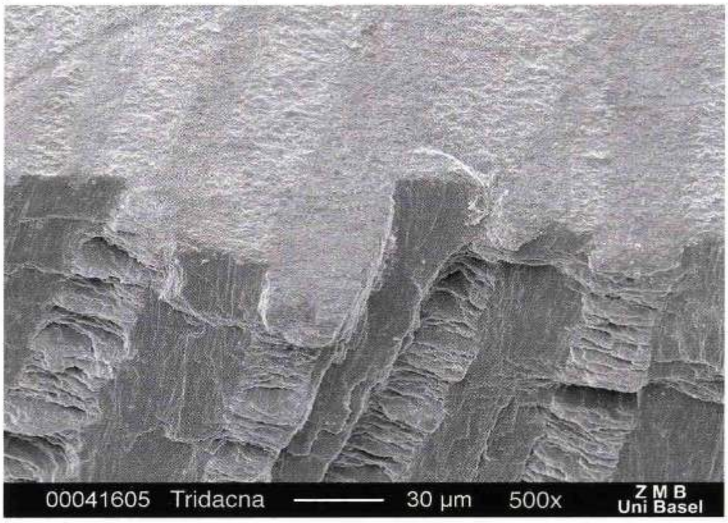


Figure 6

Scanning Electron Microscope picture of a surface - upper part - and broken surface of Tridacna shell. The crisscross structure consists of aragonite lamellae of approximately 500nm.

magnified 500x.

Picture © H. A. Hänni SSEF

*Conclusions*

The flame structure seen on some pearls of marine bivalve (scallop) and gastropod (snails) is due to a specific element in the construction of part of their shell. The inner lining of the shell consists of fibrous aragonite. Depending on the species, constituent elements have the shape of ultra-fine fibres, laths, lamellae and form bundles that are arranged in a crisscross pattern. These bundles may reflect or absorb the light that falls on the structure, letting it appear bright or dull.

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