‘Bironite™’: A new source of nuclei

by Michael Snow, Biron Corporation

Introduction

Many different nucleus materials have been used in pearling, both natural and synthetic, but shell material is predominantly the material used for round pearls.

Patents have been granted for many materials including glass ceramics, various compressed calcium carbonates materials and some mineral powder/resin composites. Lead, silver and gold were used in the early Japanese experiments and several stone materials have been employed experimentally.

Nacre will grow on nearly any solid material; indeed plastics are used for mabe production. However with round pearls where the nucleus remains, it must have a comparable coefficient of expansion to the nacre. Resins and plastic have very high coefficients leading to flaking nacre with these nuclei.

Nuclei properties

Three key properties need to exist in a round pearl nucleus:

- They must have a very similar density to the mussel shell near 2.80 g/cc for commercial weight reasons.
- They must be stable over time and capable of taking a good polish.
- They must drill well without excessive drill wear and with drilling speeds near that of mussel shell so that they can be drilled with the same drilling equipment.

Less critically the thermal coefficient of expansion must be compatible with pearl nacre. This was a major issue when the Japanese industry started to use epoxy resins filled with shell powder. The thermal expansion coefficient was far too high and the nacre flaked off.

Finally the industry strongly prefers white nuclei and so the material must be colourless. Indeed the mussel nuclei grading system is based on the degree of colour evident in the nuclei. This especially important for Akoya production where the nacre is thin, but less so for *Pinctada* pearls.

Mussel shell suffers from several disadvantages for use as nucleus material:

- It is a layered material, often colour banded and in manufacture, drilling and use it is possible for the layers to split apart. This is common in the manufacturing lapidary and it is not uncommon when drilling the final pearl.
- The hardness and drilling speed differ in the directions into and along the layers.
- It is hard to get sufficient shell to afford enough beads in the larger sizes, with the result that these are expensive and some sizes not available.

Also, mussel shell has a major disadvantage as a nucleus. It is a material that has directional properties. There is about a 2:1 variation in property values measured into and perpendicular to the shell layers. The shell layers are bound together by an organic matrix and the layers can part during bead manufacture and during drilling of the finished pearl.

We have focused on natural dolomite as a stating point for our nucleus development. Dolomite has major drilling deficiencies as a pearl nucleus. The main one is that the material is too hard for easy drilling. Materials we have tried will drill slowly, but also cause rapid drill wear. This in turn can lead to rapid over heating of the nucleus and possible cracking of the structure.

We are aware that some Korean and Japanese firms are offering dolomite to farmers as nuclei at discount prices to shell. We find this material very slow drilling giving rise to excessive drill wear. The farmers that use this material will face possible rejection of their pearls crops by processors due these very hard nuclei causing drilling problems and possible pearl failure.

An additional problem is that dolomite has euhedral (block like) crystals that do not bind together tightly. While some materials do hold together well enough others do not.

In other respects dolomite is acceptable as it does not have directional properties, polishes, has a density slightly above 2.80 at 2.84, it can be obtained white and has an acceptable thermal coefficient of expansion inside the range of mussel shell.

Bironite

In 1995 Biron, a created emerald manufacturer and gemstone distributor in Perth, was approached by the industry to develop a new nucleus material. The material had to be less expensive and readily made, to be white and have properties similar to mussel shell especially in regard to its ability to be drilled by the traditional steel spade ended pearl drills.

Biron is grateful to the Commonwealth Government for recognising the merit of the project and providing an IR&D grant over 3 years to pay half the expenses of the work. Dr. Michael Snow, a professional chemist and Director of the company led the development work.

With Mr. Artur Birkner, Dr. Snow has been able to develop selected dolomite mineral material as an ideal alternative to mussel shell. It is white and it is not colour banded nor does it have directional properties like mussel shell. This means it does not split in the lapidary or on drilling.

Bironite is a natural dolomite that has been modified by a patented process to overcome these deficiencies. It remains mineralogically very similar to the original material except that its drilling properties are substantially improved. See the table of propertiesdown below.

The Bironite nucleus has been trialed by the Australian company Atlas Pacific Limited in Indonesia and is to be trialed by three Australian groups starting this year. Atlas Pacific by the way is stock exchange.

We are also grateful to Paragon Pearling and South Pacific Nucleus for lapidary work. Pearlautore and Linneys at Broome and in Perth helped us with drilling tests. The S.A. Museum gave advice on minerals.

Frequently asked questions

Why use Bironite when mussel shell is so well established?

Bironite has a distinct advantage over mussel shell in drilling. It is a uniform natural material specifically modified for the purpose. It is able to complement the availability of mussel shell that is not always procurable in larger sizes. The taking of live mussel shell is now banned on environmental

Table 1: Properties of different materials used for nuclei

	Dolomite	Bironite	Mussel shell
Density, gm / cc	2.82 to 2.87	2.84	2.8
Hardness, (Vickers)	172 to 250	176 to 192	135 to 223
Linear Expansion Coefficient (Parts per C°)	15 to 25 x 10^{-6}	22 x 10^{-6}	14 to 35 x 10^{-6}
Appearance	Pearly lustre	High polish, icy	High polish, glassy
Colour as graded	White to black	Pure white	White to banded
Workability with pearl drill	Poor, excessive drill wear can cause cracking	Excellent, regular very low drill wear	Excellent, variable low drill wear
Relative drilling speed*	0.4 to 0.6	0.9	0.5 (±) to 1.0 (±)

grounds in many states of the USA. The mussel species has been overfished and the supply is no longer sustainable. The very slow growing times of between 40 and 80 years to maturity and zebra mussel predation suggest that the shell may not be replaced when the old shell is exhausted. Past experience has shown that the supply of shell can be erratic. Farmers commonly stockpile nuclei to ensure that this critical supply item is always available. Check the following internet site for more information: http://www.sdafs.org/meetings/98sdafs/mussels/mussels.htm

Why are the drilling properties of a nucleus important?

The industry has evolved around mussel shell. The drills used are primarily the traditional pearl drills. This drill is made of mild steel and has triangular section and chisel pointed end. While fluted and diamond drills are also used, the traditional drill is still widely used for pearl drilling. This drill is very sensitive to the hardness of the nucleus material, too hard and it will wear quickly, overheat and possibly become stuck in the pearl. If the nucleus material is too soft then it will be subject to excessive wear in use. Bironite has been specially developed to work well with the agoya drill. Bironite is a more uniform material with a relative drilling speed of 0.9 units/s where mussel varies from 1.0 down to 0.5 units/s depending on orientation.

Why not use other shell materials?

Many have been tried including giant clam and pearl shell. The former grows quickly and is very hard to drill and it is also subject to splitting. The drilling rate is about 10% of the rate of Bironite and this leads to over heating and possible rupture of the pearl. Pearl shell appears to be a good material and it is still used for buttons. The costs of using it are much greater than with mussel shell or Bironite.

Will nacre grow as well on Bironite?

Yes, our trials show nacre growth at the same rates as mussel shell. Over the last 100 years many materials have been trialed for pearl nucleus. They all grow nacre, even plastics and resins; however, the nacre tends to flake off these materials due to their large thermal expansion coefficients. Bironite on the other hand has a coefficient of expansion within the range of mussel shell and the pearl itself.

Can other natural materials be used for pearl nucleus?

Yes, in principle but no others seem to be satisfactory in practice. It is necessary to have all the properties correct such as density, drilling properties, white colour, ability to polish, and thermal expansion. This and being readily available rules other natural materials out.

Is Bironite a stable material?

Bironite is made from dolomite, a calcium magnesium carbonate formed in ancient seas. It is transformed over time with increasing temperature and pressure to a mineral stable on the geological time scale.

Are Bironite nuclei in any way artificial?

No. The pearl culturing process always involves the insertion of a bead nucleus or a tissue nucleus. Bironite is a bead nucleus of natural origin.

Can you reconstitute shell material into nuclei?

This seems an attractive idea that is not easy to realise commercially. The difficulty is in achieving the original density and polish. Cements even under high pressure yield materials with lower density and poor polish.

Is Bironite synthetic?

No. It is a natural product that has been modified and refined for its drilling ability.

Does Biron have a lapidary to process Bironite?

Yes, we have a fully equipped lapidary in Perth to produce finished nuclei.

Why does Bironite not have as high a polish as mussel shell?

Mussel shell will take a high polish, as it is a very fine-grained material although it can have several types of physical defects. Bironite is composed of crystals about 1 mm across and it will sometimes have very fine pits near these junctions. We are still developing techniques to reduce this, but we believe that this is not important for pearl development provided that these fine pits are not sources of infection. To avoid this problem the nuclei are washed in deionised water then with acetone and dried at 120°C. They are then packed hot and heat-sealed into a vacuum pack bag.

Will Bironite wear as well or better than mussel shell in necklace strings?

The wearing ability will closely follow the hardness of the material. Mussel shell varies with a range from 135 to 223 Vickers hardness that parallels the drilling results. Bironite has a hardness of 190 Vickers. Hence in a string of mussel shell pearls, some will wear at a faster rate than others will. The Bironite string will wear uniformly. In practise both nuclei will be acceptable, as it is the string itself that is the weak link in the pearl strand. Jewellers recommend that pearls be restrung regularly.

For more information, please contact Dr. Michael Snow of Biron Corporation Limited (ACN009 087 469) on 08 83447728 to discuss trials or to learn more about Bironite®.