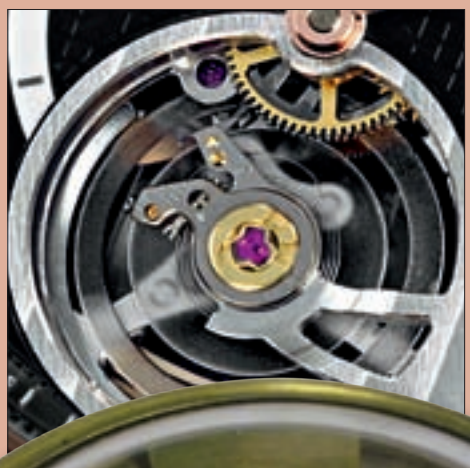
Heart of Glass

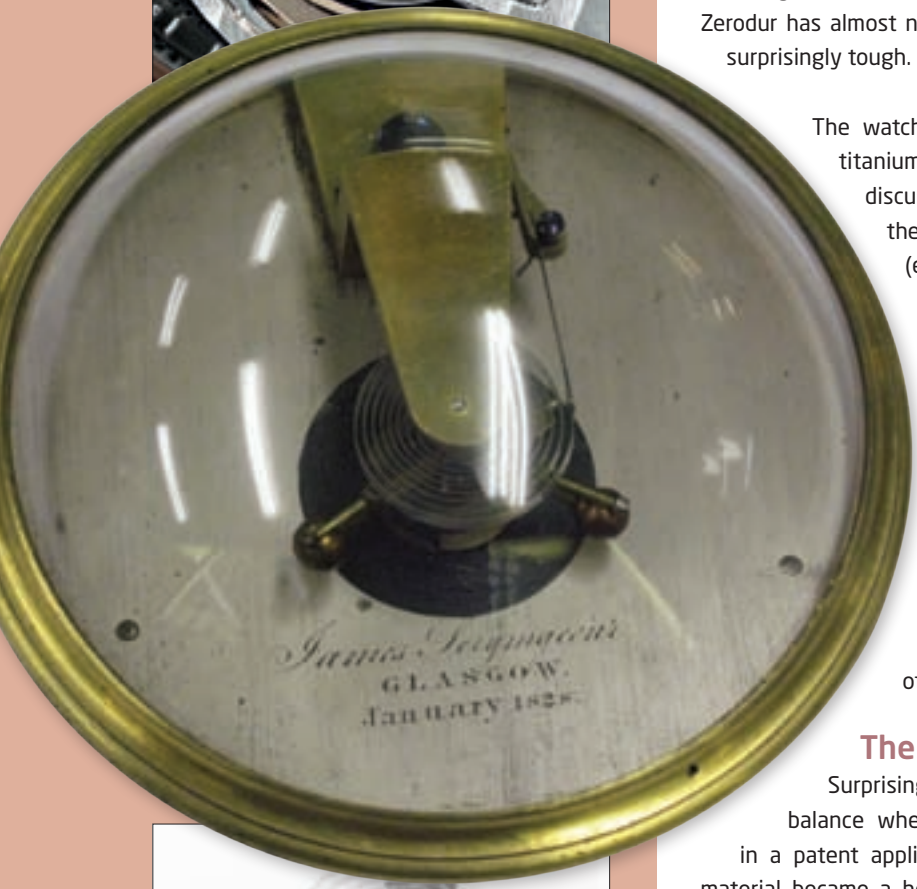
There's a story that goes round that nothing in watchmaking is new, just an adaptation of techniques from days gone by. And as much, and as fast, as watchmaking develops, the surprise is often in the existing history of the ideas being developed.

Thomas Byczkowski

Frédérique Constant has made a virtue of modest and considered growth throughout its short history and concentrated, with a barely credible persistance, on value for money. Meanwhile its rather plain manufacture is a physical rejection of the asset-bubble temples that are its neighbours in Geneva's Plan-les-Ouates (including Patek Philippe, Vacheron Constantin, Harry Winston, Piaget and Rolex's black rock of a factory). But, as the pendulum has swung towards Frédérique Constant, it turns out that creative horology is one bug that did catch.

The first the world saw of this was at the 2007 Only Watch auction in Monaco – not in itself the expected environment for Frédérique Constant. Lot 12 was a rose gold 'Heart Beat' that demanded attention due to the inclusion of two significant innovations that were sufficient to easily justify





Top: For the Only Watch auction in 2007, Frédérique Constant presented a wristwatch featuring a Zerodur glass ceramic balance wheel and a silicium escape wheel. An idea close to 200 years old, yet perfected by the application of new high-tech materials.

Middle: Demonstration model of a spiral glass spring by James Scrymgeour, Glasgow, 1822. The model now resides in the British Museum.

Bottom: Details of the balance and spring of Scrymgeour's model, showing the spiral spring, the resilient stud, and the three mercury-in-glass thermometer tubes used to provide compensation. The end of each tube is bent at 90° to lie parallel to the balance staff. Image courtesy of the Trustees of the British Museum.

the watch sharing space with *pièces uniques* from the likes of Audemars Piguet and Zenith.

And in creating these surprises, Frédérique Constant dived deep down into watch history and brought up a pearl from an almost forgotten era – early 19th-Century Britain – when, for a short time, glass seemed to have a prosperous future in the watchmaking industry. The result was a balance wheel created from a glass called Zerodur. Made by the German ceramic specialist Schott, Zerodur has almost no thermal expansion, is obviously anti-magnetic and is surprisingly tough.

The watch world is full of new state-of-the-art projects, from titanium (used by Blancpain as a balance material) to the much discussed silicon (first researched and used in the labs of the Swatch Group, Rolex and Patek Philippe), diamond (exploited as balance material by Ulysse Nardin) and even quartz and carbon (introduced a couple of years ago by scientist Gideon Levingston in balance and spring respectively). However, nobody in the industry at this stage seemed to have thought about resurrecting the use of glass, despite it possessing a lot of the properties watchmakers long for in their search for precision timekeeping.

But before going into detail about the special kind of glass Frédérique Constant introduced in its Only Watch piece, it's worth looking at why glass was ever thought of by watchmakers.

The history of glass in timekeepers

Surprisingly, glass goes back almost to the invention of the balance wheel, with its first mention coming from Robert Hook in a patent application for a glass balance spring back in 1660. The material became a hot issue again at the beginning of the 19th Century, when ships set sail for long, deep-sea voyages and the growing demand for marine chronometers drove investment into balances able to cope with harsh conditions.

Over the following 50 years, ship builders moved away from wooden hulls, in favour of steel, making resistance to magnetic fields a growing concern when it came to chronometers. For those working on glass balance assemblies, this was a huge boost as glass was widely thought of as a viable alternative to brass and other conventional materials.

In the horological department of the British Museum there are some interesting examples of balance systems made of glass, one from 1822 by James Scrymgeour in Glasgow and others from Edward John Dent, who was joint venturing from 1830 on with the late Master Watchmaker John Roger Arnold. They tested glass springs and balances, which were most likely produced by Frederick Rippon, Dent's eldest stepson. The chronometer makers applied their products to be tested at Greenwich as soon as they got them working. And despite the fear of breaking the fragile mechanism, to the Admiralty's surprise and to Arnold's and Dent's satisfaction the timepieces performed well, even after being thrown from a table – inadvertently – and

put as close as possible to a battery of firing 24-pounder guns – intentionally. Compared to those gung-ho procedures, today's chronometer tests can't help but seem a little pedestrian.

Unfortunately, the glass balances and springs, despite their durability, showed timing variations of up to 15 seconds a day. No one knew why but research into glass stopped until being revived in the mid-20th Century by Swiss scientist Professor Adrien Jaquerod of the Laboratoire Suisse de Recherches Horlogères in Neuchâtel published a paper relating to the testing of different sorts of glass – as a balance spring material.

Advantages and disadvantages of glass driven watches

Well known physicist and watchmaker Anthony Randall was also interested in the possibilities offered by glass and he clearly sums up the properties of the material from the point of view of chronometry. On the plus side is its complete indifference to magnetism and corrosion as well as the fact, that it needs far less compensation than a steel version would. Given the right choice of ingredients, it could even become insensitive to temperature changes. Together with a low density this makes up for the dream choice of any watchmaker. But against this stands an odd effect – glass is in a constant state of fluidity. In other words, it is not truly solid – even though scientists still debate the time span and possible effects of the fluid.

Having said this, as Randall knew, glass is constantly changing its solid state, with possible crystallisation and even disintegration. This of course could be the answer for Arnold and Dent's problem one and a half centuries ago. But what is more, even with the most modern methods of physics and all his knowledge as a watchmaker, Randall's glass springs (he, too was initially interested in the material for balance springs, though a lot of his tests were performed with glass balances as well), never did perform to the core.

To get on top of this, Randall induced heat treatment, metal coatings and a wide variety of other methods. Only to admit in the end, that possible micro cracks disturbed his springs and made working with them a nightmare. He did suggest different treatments to shape the properties of glass, although he never resorted to hydrogen fluoride, a glass dissolving, extreme acid that is used to flatten out the tiniest scratches of the surface and eliminates those micro cracks. Randall's conclusion was that the possibilities for glass in watchmaking could only be researched by university departments specialising in glass technology.

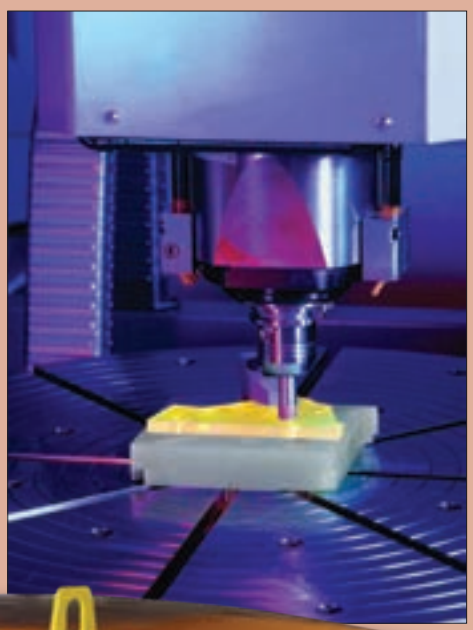
The advantage of Frédérique Constant's movement

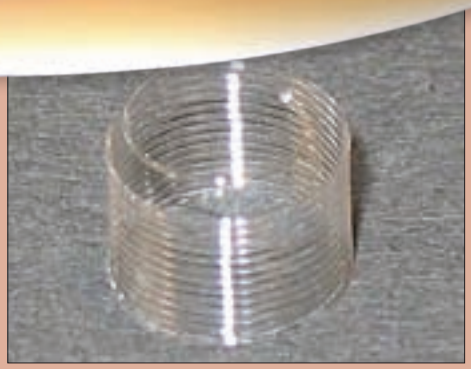
Since Randall's last tests in the 1990s, those same universities and institutes have not been sitting idle and have, in fact, developed a special type of glass, called Zerodur, utilised by Frédérique Constant. Zerodur is a product developed by the German glassworks Schott AG and has developed out of the omnipresent Ceran, which forms the surface of today's modern kitchen ceramic cook tops. It is even (and how could it not be?) used in space-technology.

The secret of Zerodur is that it is an inorganic, non-porous material, made by a process called 'controlled volume crystalisation'. This means, Zerodur contains a crystalised phase and a rest phase, which together define its properties, meaning, that it is more of a solid matter than usual glass. As

Top: Remains of a glass balance and balance spring by Edward John Dent who, in partnership with the late master watchmaker John Roger Arnold, was experimenting with the material from 1830 on. Now in the British Museum collection.

Middle & bottom: A Dent glass spring together with ebony and ivory display case, now part of the British Museum collection.





Top & middle: Frédérique Constant's new glass ceramic wheel was made possible by German company Schott's innovative solid state glass – Zerodur – currently used in such mammoth projects as India´s biggest astronomical telescope ARIES, for which Schott produced a 3.7 m diameter mirror blank of Zerodur glass ceramic.

Above: A modern representation of the glass spring by physicist turned watchmaker Anthony G Randall, now part of the British Museum collection.

stated by Schott: "Zerodur has an extreme low thermal expansion coefficient, which can even become zero or slightly negative in some temperature ranges. Another unique characteristic of Zerodur is its exceptional homogeneity." Any of the problems resulting from the fluidity of the material are therewith zeroed out.

Combining a Zerodur balance wheel with a silicium spring might be a good idea, but Frédérique Constant founder Peter Stas confirms that the production of their specially produced timekeeper for Only Watch in the given composition has already created some difficulties, mainly resulting from the fact, that it is not possible to adjust the glass wheel after it is cut into form with a CNC machine. "Also the assembly onto the axis is a big issue," Stas notes.

According to him, they were led to this material – or glass in general – by searching through all possible options: "In the past, Rolex experimented with sapphire balance wheels, but these still have expansion problems. After extensive discussions with various material suppliers, we concluded Zerodur to be the best solution. Thereafter, we worked for a long time on the CNC manufacturing of this ultra hard material."

And although his team is aware of the diamond springs used by Ulysse Nardin, they were not convinced of using Zerodur for a spring themselves. Stas did not mention, whether they came to this conclusion through realising that those two materials have completely different chemical compositions, one being of pure carbon in a special crystalisation phase called the diamond structure and the other a fluid mixture of a big portion of silicium oxide with a small but decisive amount of different minerals. Generally, the Frédérique Constant team had doubts whether this "ultra-hard material is good for balance springs".

Keeping in mind Arnolds and Dent's precision tests, the biggest question, of course, remains how well does the new system perform? Stas says that it was "running better than a typical Nivarox escapement when we tested it with big temperature variations. Under normal temperature, the system runs similar to a Glucydur balance wheel with a No. 1 spring."

But only time will tell, if this remains true for the next couple of years or if the watch will suffer from acceleration problems as the old chronometers of the 19th Century did. True enough, Frédérique Constant's Only Watch will most likely not be used as a timing device to circumnavigate the world but chances are that it will tick its time away on a cosy cushion in the safe of a knowledgeable collector.

Further Information: www.britishmuseum.org, www.frederique-constant.com