SEEING IN THE DARK

For many of those who wear watches, being able to read them in the dark is a major factor in deciding which watch to buy. The majority of watches that are made do glow in the dark; the length of time that they do and the brightness is dependent on the technology the watchmaker employs. For some users, being able to read the time all night is important, while others need only a few seconds of illumination.

Today's watches use two basic means to achieve luminosity: the application of Superluminova to the hands, dial and indices or the use of Tritium gas tubes. Superluminova is by far the more popular, although there are pros and cons to both technologies. To find out more about luminous material in general, I visited with RC Tritec, the maker of Superluminova, and MB-Microtec, one of the makers of Tritium gas tubes.

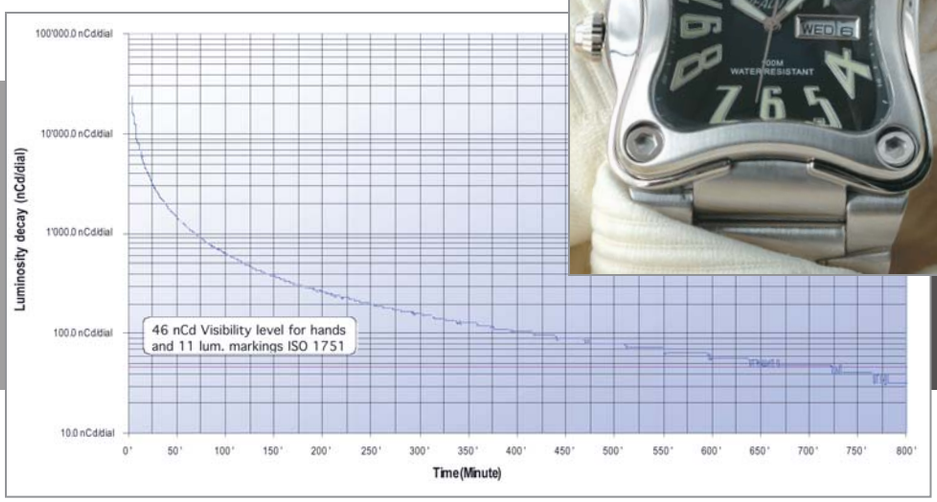
Luminous-dial watches from Ball, Mondaine and Luminox. Each uses Tritium gas tubes to illuminate the hands and markers. In our laboratory test, their brightness remained constant.

The history of watch luminosity is very interesting, indeed. In the early days of this technology, the use of radioactive luminous material was the norm and technicians were applying radioactive radium and Tritium paint by hand, taking no precautions whatsoever. "At that time, the paint was used by ateliers, which bought the powdered material, mixed it with a binder, then applied it by brush or pin to the dials and hands," says Albert Zeller, managing director of RC Tritec, which was founded in 1935. "In 1938, my grandfather started production of a radium compound in his house. After World War II, he continued with the production of radium luminescent paint. At the end of the '50s, some American customers, mainly Timex, began to request a safer, less toxic and less radiating luminescent material for watch applications. Radium emits alpha, beta and gamma rays, which penetrate the housing of the watch and irradiate the skin, giving a dose of radiation to the wearer. Old radium watches, in fact, register immediately on a Geiger counter."

Many different possibilities were looked at, and the most promising one was Tritium, an isotope of hydrogen with very weak beta radiation, which can pass only a few microns into a material before all electrons are absorbed. In fact, Tritium is the least radiotoxic isotope known, and around 1962, the entire watch industry switched from radium to Tritium.

"We were given a license by US Radium Company to manufacture this Tritium luminous compound," Zeller notes. "This continued until 1994. Everyone was using the Tritium luminous compound except for the Japanese, who had a psychological resistance to radiation because of their history with the hydrogen bomb. They used Promethium-147 (PM-147), which is also a pure beta emitter but with a shorter half life, 2.6 years."

"In December 1993, the Swatch Group's CEO, Nicolas Hayek, decided to change from Tritium self-luminous material to non-radioactive afterglow material," Zeller continues. "He wanted to use only ecologically friendly materials in his Swatch watch. In 1994, a new composition of afterglow materials came onto the market from the Far East. Nimota Ltd. of Japan patented a new



The Reactor Flux, which uses Superluminova, and its luminosity test results.

strontium aluminate material, now known as Superluminova, which was non-radioactive and showed good brightness and afterglow performance. With Superluminova, it was possible to make watches that glow for a whole night."

From 1995 to 2000, some companies stayed with Tritium; some used both Tritium and Superluminova, and some used only Superluminova. Then Superluminova—the basic raw material is provided by Nimota and RC Tritec adapts it for the Swiss watch industry—was almost universally adopted by the Swiss watch industry. Today, no companies use radium or Tritium paint, and 98 percent of the industry uses Superluminova. RC Tritec, in fact, is authorized by the Swiss government to receive watches and parts coated in radium or Tritium paint for safe disposal. While I was in RC Tritec's hometown, St. Gallen, Switzerland, Zeller showed me hands and indices from the '40s and '50s, all of which were coated in deadly radium.

SUPERLUMINOVA

Superluminova works like a "light" battery that has to be "charged" before you can take any energy out of it. When you charge Superluminova in the light (sunlight or artificial light), you lift electrons in the material to a higher level. The stronger the activation light and the longer it is exposed, the more electrons are lifted. When you turn off the light, the electrons fall down, and the energy is released in the form of light. The luminosity is brightest at the beginning and then dies down until it eventually loses all its visible brightness.

Because it is not a chemical process but a modification of a crystal, Superluminova doesn't lose its effectiveness over time; its half life is 12.5 years, and it maintains constant brightness throughout its life.

What makes one Superluminova watch's luminosity better than another? It comes down to the amount of material used and the way it is applied to the watch. None of the watch brands do their own application of Superluminova; it's all done by small ateliers throughout Switzerland. Companies specify how much, how and where to apply the Superluminova material, and that's what makes the difference.

"The determining factor is the amount and thickness of Superluminova material, as well as the color, because Superluminova comes in a number of colors," says Zeller. "The more material you apply on the dial and the hands, the higher the light storage capacity. Watch brands can use different grain sizes of Superluminova material. For certain designs, the small grains are used to make smooth, shiny surfaces, but they are a little weaker."

Superluminova is an expensive material, but the amount of material used on a watch is miniscule. "With one gram of material, you can luminize between 200 and 1,000 watches," Zeller details. "With one kilogram, you can make between 200,000 and one million watches. The average cost of the material is only a few cents per watch, but the application cost is about ten to twenty times the material cost. If you have a complicated application, all done by hand, the cost is much higher."

Reactor's president Jimmy Olmes's goal is to make the best performance sport watch on the market, regardless of cost. "Being able to read the time in darkness is one of the features that is necessary in order to achieve this goal," he says. "There is really no secret to making the dials highly luminescent: the larger the markings and the thicker you apply the material, the more hours of readability. The secret is in the techniques of achieving this. We now believe that we can get to 24 hours of readability, and we are working on ways to apply the Superluminova to achieve this goal." There is a research association in Switzerland that is intent on finding new luminous materials, and RC Tritec is participating, but nothing better than Superluminova has been discovered so far. There are fake materials out there and material that is manufac-

above—The Panerai Luminor Marina and its luminosity test results.
below—The Tutima DI300 with its luminosity test results.

tured using the formula patented by Nimota but without a license, although Nimota is aggressively defending its patent.

TRITIUM GAS

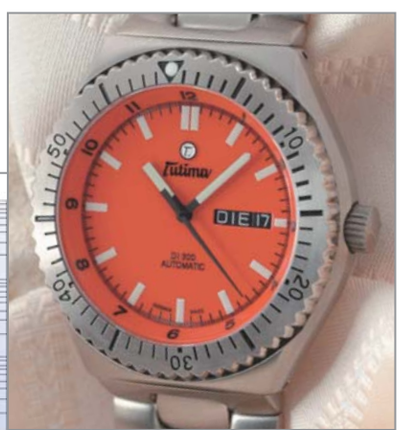
In watches that use Tritium (officially, gaseous Tritium light source or GTLS), glass tubes holding Tritium gas are placed in the watch under the crystal. "The tubes are made of borosilicate glass, which is temperature resistant," explains Jakob Bänziger, general manager of MB-Microtec. "The tubes are sent to us in large sections, then we make the tubes smaller and longer. We wash them and apply a coating of phosphorous material inside, then we close them on one end, pump out the air, fill them with Tritium gas, and then we have a light source which is half a meter in length."

"We then seal off the lengths with a special laser technology that we developed ourselves 25 years ago," he continues. "We do a lot of testing to make sure they have the right brightness and, more importantly, that the tubes are not leaking. We follow the requirements of the American standard, ANSI 43.4-2000—each light is tested to make sure it doesn't release Tritium. After the testing, they are ready to be used in watches or other applications."

The level of brightness of the tubes is determined by the pressure of Tritium in the tube, which is determined by the amount of Tritium gas present (from 0 to 2.5 bar of gas). There is, according to Bänziger, no official standard, but MB-Microtec has established a few sizes of GTLSs, and the company can also make custom sizes as long as it is technically possible.

While there is some radiation in the Tritium tubes, it is nearly impossible for the radiation to leak through the tubes and the watches they are used in. If the crystal of the watch and the tubes were to break, the Tritium would be released into the atmosphere, although everyone I talked to about potential danger asserted that there is no risk even if hundreds of watches were broken at once, releasing a large amount of Tritium. Whether or not this technology is used is a personal choice. Tritium watches won't lose their practical luminosity for four to six years or more. Superluminova, however, will never lose its luminous quality, though it does have to be charged by a light source.

There are certainly applications where Tritium is called for—military, law enforcement, government and so on—areas where it's imperative that timepieces be legible in darkness, regardless of the availability of a light source.



PERFORMANCE

All the watches performed well. The Superluminova watches started out very bright but after a few hours started to lose luminosity. The Tritium-equipped watches scored the best when it comes to the length of luminosity because they hold the same practical brightness for four to six years, although they didn't always start out as bright as the Superluminova watches. The time listing in the results is the amount of time it took for the luminescence to dip below the ISO standard (ISO 3157) for visibility. Since Tritium-activated watches maintain brightness for years, the ranking is listed for brightness after three minutes. Finally, the ranking for brightness after three minutes for all watches is listed.

SUPERLUMINOVA: TIME PERIOD OF LUMINOSITY

- Reactor Flux: 723 minutes (12.05 hours)
- Tutima DI300: 529 minutes (8.82 hours)
- Panerai Luminor Marina: 461 minutes (7.68 hours)
- RGM Lancaster: 350 minutes (5.83 hours)
- Hamilton Khaki Frogman: 325 minutes (5.42 hours)
- Chase-Durer Special Forces 1000: 142 minutes (2.37 hours)

SUPERLUMINOVA: BRIGHTNESS AFTER THREE MINUTES

- Tutima DI300: 28,223 nCd/watch
- Reactor Flux: 24,060 nCd/watch
- Panerai Luminor Marina: 14,854 nCd/watch
- RGM Lancaster: 8,972 nCd/watch
- Hamilton Khaki Frogman: 7,075 nCd/watch
- Chase-Durer Special Forces 1000: 2,267 nCd/watch

TRITIUM-ACTIVATED: BRIGHTNESS AFTER THREE MINUTES (LENGTH CONSTANT: AT LEAST 12.5 YEARS)

- Ball Engineer Hydrocarbon TMT: 6,504 nCd/watch
- Mondaine SBB Sport Night, white face: 5,717 nCd/watch
- Luminox Model 7001: 3,612 nCd/watch
- Mondaine SBB Sport Night, black face: 3,000 nCd/watch

SUPERLUMINOVA AND TRITIUM-ACTIVATED: BRIGHTNESS AFTER THREE MINUTES

- Tutima DI300: 28,223 nCd/watch
- Reactor Flux: 24,060 nCd/watch
- Panerai Luminor Marina: 14,854 nCd/watch
- RGM Lancaster: 8,972 nCd/watch
- Hamilton Khaki Frogman: 7,075 nCd/watch
- Ball Engineer Hydrocarbon TMT: 6,504 nCd/watch
- Mondaine SBB Sport Night, white face: 5,717 nCd/watch
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- Chase-Durer Special Forces 1000: 2,267 nCd/watch

The RGM Lancaster Chronograph with luminous markers and hands.

THE TEST

InSync arranged to have select watches of each kind tested to see how they would fare. The longer the watches remained readable, of course, the better. The luminosity testing was performed at the RC Tritec facility in St. Gallen. We decided to use the standard ISO test, which charges the watches with a regulated amount of light (20 minutes at 400 lux, using a D65 type electric light).

Technicians analyzed the brightness after three minutes and measured how long it took for the luminescence to fall below the ISO standard for visibility in nanocandela (nCd). The watches using Superluminova (Chase-Durer, Hamilton, Panerai, Reactor, RGM and Tutima) glowed very brightly at the start, dropped off quickly in the first hour, then continued losing brightness, but at a much slower rate. The watches using Tritium glass tubes (Ball, Mondaine and Luminox) don't start out nearly as bright as the Superluminova watches, but they do not lose any of their brightness (as you can see from the test results graphs).

The luminosity chosen really depends on what the watch buyer wants and needs. If requiring a watch that is luminous without having to be exposed to a light source, or requiring luminosity over a longer period of time than is possible with Superluminova, the user should consider a watch that uses the Tritium gas tube technology. It may not glow as brightly as Superluminova at the beginning, but it will maintain a steady state of luminescence. If the watch needs to be visible throughout the night,

Superluminova is a great choice. Whichever technology one chooses, there are a lot of excellent watches that allow one to see in the dark. ❖

Article by Keith W. Strandberg, InSync *watch editor. Photos by* InSync.