The Quest for the Glowing Glaze

By Sarah Rossiter

Brian Jensen’s quest for glowing glaze began in the town of Edinboro, Pennsylvania, with professor Steve Kemenyffy’s challenge to graduate students to develop cutting-edge ceramics technology. Jensen’s search for the alchemy of photoluminescent glaze would lead him from the 1920s marble factories of Sisterville, West Virginia, through the aisles of a toy store and the treacherous corporate straits of a multibillion-dollar glow-in-the-dark industry to starting his own business and offering the first glow-in-the-dark ceramic glaze on the market—Gloze.

The Spark

After graduating from Southern Utah University with a degree in art and secondary education, Jensen taught high-school ceramics in Cedar City, Utah. He then earned his M.F.A. in ceramics at Edinboro University of Pennsylvania (EUP), where he initially undertook developing not a glow-in-the-dark, but a fluorescent glaze. Kemenyffy is a passionate and unflagging proponent of artists developing and using new technologies. He advocates innovation by asking, “If it’s out there, can we adapt it to ceramics?” His commitment to innovation motivates his ongoing challenge to students to develop new ceramics technology. Kemenyffy said, “I told Jensen, ‘Go by analogy. Go by things that have been tried in the field of glass and apply them to glaze,’ which struck a chord with him because of his interest in marbles.”
Jensen had been collecting marbles since he was a kid and began collecting seriously when he moved to Pennsylvania for graduate school. He was making porcelain marbles by day and glass marbles by night. Marble collectors often use a black light to identify antique marbles colored with uranium oxide, which were manufactured by several companies during the 1920s and 1930s. Uranium glass, sometimes called “Vaseline Glass,” glows when exposed to ultraviolet (UV) light. However, uranium was used not for its fluorescent qualities but for the yellow-green color it imparted to the glass. At the time, uranium was an unregulated byproduct of radium production, and a cheap, abundant and popular colorant for glass and glazes.

At the Marblefest in Sisterville, Jensen purchased some waxy-yellow, antique uranium glass and brought it back to Edinboro. Kemenyffy described the pieces of glass: “They did not glow in the dark, but they just had a brilliance to them when you took them outside. Sunlight made them more vividly colored because of the interaction with the UV light.” The unearthly color of the glass results from uranium converting UV light into visible light. Thus, unlike most objects we perceive, the glass both reflects and emits light.

Although uranium is radioactive, Jensen speculated that the glass was less radioactive than Fiestaware, a popular and collectable line of commercially produced ceramics that featured a uranium red glaze in the 1930s and 1960s. The website of the Uranium Glass Gallery in Japan indicates that most uranium glass contains 0.1–2% uranium, and that a small glass object with a uranium content of 0.1% would produce radioactivity roughly equivalent to that of the total potassium in the human body. Nevertheless, Jensen decided to keep the glass at the studio and not at home with his family. He also decided not to carry the glass in his pocket or call it “my precious.”

In order to satisfy his curiosity about the uranium glass and find out exactly how dangerous it might be, Jensen took it to the EUP chemistry department to see if anyone there could tell him more about its properties. He mostly learned that people reacted to the uranium glass with barely concealed panic. One professor, upon learning that the glass was colored with uranium, tossed the glass back at Jensen like a hot potato and virtually pushed him out of the office. Alarmed that perhaps he had underestimated the danger of the glass, Jensen hustled out of the chemistry department with the uranium glass at arm’s length, increasingly concerned that the radiation might rob him of his superpowers or make Swiss cheese of his organs on the short walk to the physics department.

To Jensen’s relief, Professor Thomas Walkiewicz tested the uranium glass with a Geiger counter and demonstrated that it was, in fact, less radioactive than the standard fluorescent light fixtures in his office. The radioactivity of the yellow and black uranium oxide Jensen had obtained was similarly weak. Fiestaware, on the other hand, maxed out the Geiger counter needle, even on the least sensitive setting. Reassured, Jensen set about converting the glass into a glaze. But after melting the crushed glass inside some clay forms, Jensen concluded that the results were not dramatic enough to merit further exploration, particularly since viewing their fluorescent effect required a black light. He also decided that he did not want to invest time developing a glaze, however safe, that people might fear.

Around the same time, Jensen found himself in a toy store shopping for Christmas gifts for his kids. He came across what he described as “some kind of glow-in-the-dark snotty goop, packaged in the shape of a light bulb.” The symbolism of the light bulb was not lost on Jensen, who realized that the existence of child-safe glow-in-the-dark products meant it might be possible to develop a safe glow-in-the-dark glaze. He decided to investigate what makes glow-in-the-dark objects glow in the dark and began
his research on the Internet. He eventually found a company that claimed their product could handle extremely high temperatures and thus began his true quest for the glowing glaze.

**The Technology**

Glow-in-the-dark technology is based on the physics of luminescence. Luminescence is cold light, generated not by heat but by an atom expelling energy as light, allowing an excited electron to drop to a lower energy level or orbital. A phosphor is a substance that luminesces (gives off light) by converting nonthermal energy into visible light. The energy source can be electricity, nuclear radiation, chemical reaction, mechanical action or light, including gamma rays, x-rays and ultraviolet light. During the process of charging or energizing a phosphor, the energy source boosts a phosphor's electron into a higher-energy orbital. Electrons, like many of us, prefer to relax in their lowest energy state. In order for the electron to return to its original, lower energy level, the phosphor emits as visible light the difference in energy between the electron's higher and lower energy states. The color (wavelength) of light emitted by the phosphor depends on exactly how much energy the electron releases in this process.

Phosphors are characterized by the type of energy required to charge them, the color of light they emit and the duration of their glow after charging (called persistence). Photoluminescent substances are those in which the phosphors are charged by light energy, whereas fluorescence is typically understood to mean luminescence caused specifically by UV light. During photoluminescence, a small amount of energy generated by the vibration of the atom during excitation of the phosphor is lost as heat. This energy loss results in the received higher-energy light being changed into the emitted, lower-energy, visible light.

The term phosphorescent describes materials that have long persistence, an afterglow, continuing to emit visible light after the charging energy source is removed. Over 500 naturally occurring mineral species fluoresce when exposed to UV light, but few materials are phosphorescent. In practical terms, this means that many materials will glow while exposed to a black light (a primarily UV light source), but few materials glow in the dark.

Most minerals also require an activator—an accompanying mineral or impurity—in order to perform as a phosphor, and the activator frequently determines the color of the emitted visible light. Uranium is one of the few self-activated minerals, those that fluoresce in a pure form. The overall color of light emitted by a luminescent substance can be varied by using different phosphors, different activators with the same phosphor or by using combinations of different phosphors.

Gloze uses the most advanced glow-in-the-dark pigments currently available, which are based on a europium-activated strontium aluminate phosphor \((\text{SrAl}_2\text{O}_4:\text{Eu}^{2+})\) grown as pure glow crystals using patented technology.

**Application and Performance**

The new glow-in-the-dark pigments charge to full capacity in a relatively short period of time and, properly fired, will glow for up to 12 hours after sufficient exposure to a UV light source. “Gloze glazes glow brighter and longer if they are applied thickly and fired quickly,” ideally reaching Cone 08 \((1750°F, 955°C)\) in 15 minutes, according to Jensen. A fast firing and cooling cycle is essential to Gloze performance because the glow-in-the-dark pigments degrade with prolonged exposure to heat. Consequently, it
does not respond well to multiple firings. Jensen speculates that it could probably handle temperatures higher than Cone 08 if it could be fired and cooled quickly enough. Other factors that enhance performance are a white clay body and sufficient exposure to a UV light source, preferably sunlight.

Glaze colorants can be added to change the daylight color; however, it is important that the glaze does not become too opaque. Opacity will block UV light from charging the glow crystals and will also interfere with the emitted visible light, diminishing the overall glow-in-the-dark performance. Gloze glows most brightly as a stand-alone glaze, but Jensen has achieved good results firing it as an overglaze on ceramics previously fired to Cone 10 in reduction, salt and soda kilns.

Gloze yields favorable results on most white earthenwares, particularly low-fire talc bodies. For a crackle effect with raku firing, Jensen suggests using a sturdy, white stoneware. Although he typically mixes his own clay, he has used premixed clay for making the glaze buttons he distributes promotionally. Jensen recommends testing the glaze on your own clay body at a variety of bisque temperatures before using it on your work.

In order to optimize his firing speed to achieve maximum glow, Jensen says, “I made stilts and shelves from soft brick. It allows the kiln to fire faster by lowering thermal mass. I also wrap my kiln in fiber to hold heat and I sometimes preheat the kiln to be able to fire super fast. I tried to fire daily when I was testing a lot and I put in as many tests as the kiln would hold.” Jensen estimates that, in the course of developing Gloze, he tested somewhere between 3000 and 4000 glazes. He has not noticed any deterioration of the bricks in his kiln, despite the frequent fast firings. However, it does strain the elements and he changes them after 20–30 firings, whenever the firing time to Cone 08 creeps above 20 or 25 minutes. He has also achieved excellent results firing in an old electric kiln that he converted into a single-burner gas kiln and fires in oxidation. In order to reach Cone 08 faster, he sectioned off a portion of the kiln with soft brick to decrease the internal volume. He suggests that people firing glow-in-the-dark glaze on larger work use two kilns—as many people do for raku firing—using one kiln to preheat the work before transferring it to the second kiln, which is maintained at or near Cone 08.

**Product Development**

The initial secrecy that shrouded Jensen’s development of Gloze was motivated by uncertainty about his ultimate goals in developing the glaze and by his unfamiliarity with intellectual property laws and contracts. In order to establish a working relationship with the glow-crystal company, he had to sign a noncircumvention agreement, which stated that he would not take any promising discoveries he made using their product and patents to any of their competitors. He also signed an agreement stating that he would focus exclusively on products related to ceramics. The glow-crystal company had focused their research on the product’s materials compatibility, but had little information about its thermal tolerance. Consequently, they were eager for some useful, first-hand information on the subject. They speculated that the glow-in-the-dark pigment might be able to handle temperatures up to 3632°F (2000°C). But in firing the material to Cone 10—a comparatively cool 2350°F (1290°C)—Jensen found that, while it did not vaporize, the fired material glowed not a whit. He remarked, “It was quite a trial-and-error project when I started, because I knew nothing about my materials and how they acted or reacted to ‘normal’ ceramics practices.” After what he calls “trial and lots of error,” Jensen learned that the glow-in-the-dark pigment required a fast firing and cooling cycle for optimal glow performance. Having found the key to this glaze, and having overcome the greatest challenge of his quest, Jensen set about refining the firing cycle and resolving glaze defects caused by the refractory nature of the glow-in-the-dark pigment.

After successfully developing the glaze, Jensen and the glow-crystal company discussed options ranging from starting a tile factory to selling the technology. Jensen also spent some time working for them as a consultant to a tile manufacturer, a marble manufacturer and a glass company. When he initially approached the tile manufacturer about his glow-in-the-dark glaze, they expressed little interest, saying they had been working with glow-in-the-dark glaze for 30 years. Their glazes used older, sodium-based, glow-in-the-dark technology, which typically yielded unremarkable results and had not merited much pursuit. Jensen persisted and sent them some Gloze-glazed tiles. Upon seeing his results with the newer strontium aluminate phosphor, they were eager for more information, and after several months of discussion ultimately offered Jensen a job with their company. He was seriously considering their offer, debating the merits of leaving his teaching job to work in industry and how that would impact his...
family and career. He was perplexed when they abruptly ceased communication with him and particularly so when they would not return his phone calls. After several weeks, he spoke with his contacts at the glow-crystal company and learned, to his disappointment and chagrin, that the job offer had been a shady attempt by the tile manufacturer to circumvent the glow-crystal company's noncircumvention agreement.

Jensen had similarly disenchanting experiences, minus the job offer, working with other companies, and has mixed feelings about working with industry. He reflected on his experiences, saying, "I learned that, when patents and intellectual properties are concerned, people can be very cutthroat. There were a lot of contracts and paperwork I had to go through and sign before I could even talk to some of these companies." But, while Jensen did find some aspects of working with industry frustrating, he also found it challenging and fascinating. He enjoyed sharing information with engineers and production managers, and learning about the research-and-development process. "That was probably the most interesting aspect of dealing with industry," Jensen commented. "Their terminology was different. Their kilns were different. I guess their whole perspective on clay was different and new to me, but very interesting—so much so that I considered a job in industrial ceramics."

Eventually, the glow-crystal company decided that ceramics was not their immediate priority. Jensen, after considering how he wanted to invest his time, resources and energy, decided to steer away from industry. He concentrated on starting his own business, offering Gloze glaze to the market he knows best—artists and ceramists. Jensen said, "I decided I wanted to make the product available to the public so others could find new and interesting uses for the glaze." With the help of his wife, and with a website designed by one of his students, Jensen introduced Gloze to the market in early 2003, launching it at the National Council on Education for the Ceramic Arts (NCECA) conference in San Diego, California.

Gloze has great possibilities beyond the novelty realm of glow sticks and celestial stickers. Like any new technology or tool, it has the potential to be used because of its "wow" factor. From an artistic standpoint, the most successful uses will probably be those in which the photoluminescence is significant to the function or content of the piece or the way in which the work connects with its audience. From a practical standpoint, Gloze might be used to glaze lamp bodies that act as nightlights or for locate-in-the-dark door handles or candleholders. Other possibilities include tiles for mosaics or egress systems in commercial buildings, counters, stair risers, coping around pools and hot tubs, or bricks to line a driveway or garden path.

Ultimately, Jensen’s synthesis of information from glaze chemistry, antique glass and cutting-edge photoluminescent materials to produce new technology in ceramics testifies to the importance of looking beyond the confines of our medium to innovation.

Kemenyffy related a story that encapsulates both the significance and the possibilities of this innovation:

"When Jensen sent me the first batch to play around with, it was winter. We’re living in a technologically crazy era, so it’s hard to impress people—so much new technology and new stuff going on. It was late, dark, and I was just getting home. When I saw all the lights on in my studio, I thought, damn! I left the lights on. But I walked into my studio and there were no lights on. Because I’d been working with the glow-in-the-dark stuff in my studio, my spray gun, spray booth and all the the things I had used with the glow-in-the-dark stuff was glowing intensely. Now, technically, we’re talking overspray, and it still lit up my studio. That’s the good news—it’s kick ass!"

For more information, or to purchase Gloze glaze, visit www.glowingglaze.com.