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Man-made Crystals

A Review of their Historic and Contemporary Context and Use

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Man-made Crystals: A Review of their Historic and Contemporary Context and Use

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Abstract: This paper reports on the history and use of man-made crystals for jewelry in a contemporary context. The cross-disciplinary contextual review traces human fascination with gemstones back centuries, and covers key developments in their "imitation." The infiltration of these man-made crystals in the market sparked the development of the discipline of gemology, through which they are often painted in a negative light. With innovations in the growth of man-made crystals revolutionizing other industries (engineering, technology, etc.), and their distinction from mined crystals increasingly more challenging, the paper reports on the terminology prescribed to the industry to describe man-made and mined crystals. These descriptions, which include "natural" and "real" versus "synthetic," are interrogated in relation to key texts and a need for the identification of an alternative terminology is proposed. The jewelry industry remains apprehensive about the influx of man-made crystals, and only a small number of man-made crystal suppliers are growing crystals for the purpose of creative exploration beyond the imitation of mined crystals for jewelry. Through the review of artifacts, where man-made crystals have been used, their ability to enable creativity is highlighted, and their further future creative possibilities explored.

Keywords: Man-made Crystals, Jewelry Design, Contextual Review

A History of Crystals Growth and the Birth of Gemology

Gemstones have long captivated human imagination. They have been greatly valued throughout time and their use can be traced back centuries (Ogden 1992), even inspiring many myths. When we speak of a treasure, we do not have to look far in popular culture to see gemstone-filled boxes, or a large crystal at the center of attention (e.g., The Pink Panther movies). Perhaps human ingenuity can be traced back as far as our fascination with gemstones. As the following examples will demonstrate, it has been a human desire to recreate and imitate that which is considered valuable, including gemstones. Pearls were imitated in great numbers by the Romans, and later Assyrian *paste*, a glass imitation for gemstones, was very popular in Europe (Pearl 2011; White 1961). Jack Ogden, in his book *Diamonds: An Early History of the King of Gems* (2018), documents and describes a range of examples, including crown jewels and pieces dating back to ancient India, where "imitation" diamonds were incorporated.

It is not until the nineteenth century that successful experiments resulted in the first man-made crystals. Even though knowledge of the nucleation of crystals can be traced back further, the necessary advancement of technology in the nineteenth century resulted in the first man-made crystals being successfully created (Arem 1973). Regardless of the many who were experimenting with crystal growth in the nineteenth and early twentieth centuries, it is A. Verneuil who is considered the father of the technology (Scheel 2003). His fusion growth method from 1902 led to the first commercial production of crystals, and even though the technique is still used today, it also led to the development of a range of other techniques, including growing from the melt, for example the Czochralski process, which was named after its inventor (Scheel 2003).

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The influx of these man-made crystals in the market ultimately inspired the development of the branch of mineralogy and geoscience we now know as gemology (Dieulafait et al. 2011), set up to distinguish the mined gemstones from imitations. The sharing of rudimentary principles of the practice began in the nineteenth century, with the first official qualifications being developed and accredited by the National Association of Goldsmiths of Great Britain (NAG) through their gemological committee called the Gemological Association of Great Britain (Gem-A). Not much after, in 1925, the first laboratory was set up in London, which provided a gemstone identification and authentication service to jewelers. Early gemology books, like *Gemstones* by G. F. Herbert (1912), clearly depict man-made crystals as less valuable and fake, even going as far as referencing the knowledge and techniques employed in the endeavor as "weapons." To date, the limited literature available that is dedicated to man-made crystals in a jewelry context (Arem 1973; Elwell 1979; O'Donoghue 2007; Pedersen 2004; O'Donoghue 2008) has mainly been produced in the field of gemology, with a clear aim to enable the continued distinguishing of mined stones from their man-made imitations.

Since the field of gemology was developed to support the identification of gemstones, it therefore also serves as authenticator of value. With certain gemstones assigned great value, classification systems and formulae for the valuing of gemstones based on size and quality ensured clarity of value. For diamond, for which there are records of its prices dating back over a millennium and price lists including formulae for calculating its value for at least half that time (Ogden 2018), a very recognizable system was introduced in 1940 titled the 4 Cs. Clarity, Cut, Carat (weight), and Color were identified as the quality beacons (Bergstein 2016). Even today, there is an option to buy a certified diamond, which comes with a report on its performance against these four characteristics, and the better the diamond scores, the higher value it is. This system, which certainly supported the rise in sales for diamonds, as it resolved the issues sellers of diamonds had explaining why certain stones cost more than others prior to its invention, is now, in certain instances, also being used for laboratory-grown diamonds. Since laboratory-grown diamonds are created to score as high as possible in the criteria, an alteration to the approach might now be on the way. Even though many news articles are currently circulating the jewelry trade press surrounding man-made materials and their quality and sustainability credentials, little literature in the jewelry context to date portrays man-made crystals in a positive light.

Modern Crystal Growth Science

In other industries, meanwhile, crystal growth is driving innovations, for example in technology, medicine, electronics, and even nuclear-physics experiments now use grown crystals (Scheel 2003). Tens of thousands of tons are produced annually, of which the bulk consists of the semiconductors silicon (Scheel 2003). Even though it is a small percentage of the amount of crystals grown annually, nearly all crystals commonly used for jewelry can now be reproduced in the lab and these imitations are making their way into the market. Year on year, statistics are indicating the segment is growing (Bain & Company 2019), particularly due to the more recent advancements and interest of a number of companies in the growth of diamond.

> It is generally accepted to-day that diamond has never yet been artificially formed, and, moreover, with the means at our disposal its production in the factory or laboratory is unlikely in the extreme. Jewellers may therefore rest assured that there is no risk of catastrophic disruption of their trade by the provision of a supply of cheap synthetic diamonds, and that any one claiming to have produced such stones is suspect.
> (Herbert 1912, 138)

In contradiction to the writing of Herbert (1912), it is now possible to grow diamonds. Grown most commonly using Chemical Vapor Deposition (CVD) or High Pressure High Temperature (HPHT) processes, these diamonds are chemically and physically identical to mined diamonds. There are a couple of books available that reference the story of the invention of man-made diamonds in a light-hearted way, including *The Heartless Stone* by Zoellner (2007) and *Brilliance and Fire* by Bergstein (2016). In addition, there is a large selection of literature that documents the techniques and the application of grown diamonds in a range of other industries, available through science journals and crystal-growth science literature.

With a serious interest in crystal growth in a variety of industries, there is a vast amount of literature dedicated to the documenting of techniques, reporting of research, and exploring of applications in relation to crystal growth. There are research centers, conferences, and journals on the subject, where subject specialists are working or reporting on crystal growth in a myriad of manners and for a range of applications. However, in line with the small percentage of man-made crystals that is annually produced for the jewelry market (Scheel 2003), there is little or no literature investigating the opportunities and innovations for the incorporation of man-made crystals in a jewelry context. It appears that the small amount of crystals produced that make their way into the jewelry market is mainly produced to imitate mined crystals, and hardly any of the innovations taking place across other fields lead to innovations within the field for which they were originally produced.

There are some exceptions where stones have been grown outside of the blueprint found in nature; for example, Swarovski's vibrance collection of Cubic Zirconiums (CZ), launched in 2020, contains four Cubic Zirconium (CZ) stones that display color combinations that would not be found in nature (Swarovski n.d.). Another example of an innovation in the use of laboratory-grown crystals was achieved by the company Lonite (Lonite n.d.), which is one of a number of companies who have been able to perfect the technique to grow diamonds from the carbon extracted from the ashes of a loved one who passed away. With most of the research in crystal growth conducted by trained scientists and a hostile jewelry market, it is perhaps no surprise there is little to no cross fertilization of developments innovating other fields and the jewelry industry.

Man-made Crystals for Contemporary Jewelry

Having identified the industry has been keen to clearly distinguish mined gemstones from man-made crystals, it is worth exploring how these crystals, which have become indistinguishable from mined crystals, are currently positioned, used, and valued outside of the realm of gemology.

Marketing Regulations for Man-made Crystals

Driven by the mined industry, spearheaded by the Natural Diamond Council (previously known as the Diamond Producers Association), which is composed of seven diamond mining corporations representing 75 percent of the diamond mining industry, legislation and guidelines to market and sell man-made crystals, and particularly diamonds, has been devised and published by the Federal Trade Commission.

> It is unfair or deceptive to use the word "ruby," "sapphire," "emerald," "topaz," or the name of any other precious or semi-precious stone, or the word "stone," "birthstone," "gem," "gemstone," or similar term to describe a laboratory-grown, laboratory-created, [manufacturer name]-created, synthetic, imitation, or simulated stone, unless such word or name is immediately preceded with equal conspicuousness by the word "laboratory-grown," "laboratory-created," "[manufacturer name]-created," or some

> other word or phrase of like meaning, or by the word "imitation" or "simulated," so as to disclose clearly the nature of the product and the fact it is not a mined gemstone. (Federal Trade Commission 2018, 40674)

The lobbying to achieve this guidance, in addition to large amounts of money spent on advertising, educational materials, and resources, are all part of the mined industry's strategy (of which the largest is the diamond industry) to ensure efforts to distinguish man-made from mined stones is now a matter of terminology and legality rather than gemology. Since methods to distinguish man-made crystals from mined stones have become less effective, their value is determined by social construct.

Material Perceptions and Authenticity

With legislation at hand, the mining industry has not only lobbied to have terminology prescribed for man-made crystals; it has also coined its own terms to use when describing their produce. A clear example of an attempt to connect the word "natural" to diamonds has been the rebranding of the Diamonds Producers Association (DPA) to the Natural Diamond Council in June 2020 (The National Association of Jewellers 2020). With the additional use of the adjective "real," the aim is transparent: depicting man-made crystals as unnatural, artificial, and fake.

With these changes having only taken place recently, little literature, outside the standard popular press reporting, has investigated the suitability of these terms in this context. The debate around the appropriate defining of materials as natural or artificial is, however, not new, and there are some key texts that aim to unpack these terms in relation to materials. Ezio Manzini's *The Material of Invention* (1989) calls for a scale of depth to be assigned to artificiality, which is in turn further explored by other writers like, for example, Lerma and Palù (2019) in their paper "Natural Materials: A Family on the Move, But Where Is the Last Stop?" The latter explores materials through a multicriteria analysis and aims to map the difference between a "natural material" and a "sustainable material." Following the writing of Esther Leslie in her book *Synthetic Worlds: Nature, Art and the Chemical Industry* (2005), all that is natural and can exist is natural, but when a material or product has been exposed to a specific process, it is considered synthetic.

If the process a material or product has been exposed to determines whether a material is "unnatural," "synthetic," and/or "fake," who decides which processes are acceptable and which are not? To illustrate the complexity, we could compare the production of cotton or extraction of gold with the growth of diamonds. Cotton is grown and seeds are harvested, which are refined into thread; a fabric is formed, which is shaped and dyed or other post processes are applied before it is used as a product. The laboratory-grown diamond is grown from a seed, cut, faceted, and polished into a shape, before it is incorporated into jewelry. Cotton is subjected to substantially more processes than the laboratory-grown diamond—so why is the one considered natural and the other artificial? Perhaps Lydia Pyne's (2019, 179) conclusion is a suitable one: "Objects don't have an intrinsic morality to them – context is everything.' If context is, in fact, what defines a material's authenticity and in turn the terminology that can be associated with it, then it is important that definitions continue to be challenged, not only by the industry when it could have commercial consequences, but also by those appropriating these materials as authors and those acquiring them as consumers.

The mined industry has been keen to align with the writings of Humberto Maturana (1980) promoting the ahistorical and autopoietic process with which mined crystals come into being, therefore distinguishing them as natural from their "artificial" competitors, whereas the laboratory-grown crystal companies have wanted to promote the sustainable nature of the laboratory-grown crystals. In marketing literature, there is plenty of work prescribing the benefits of aligning your

product with the ongoing trend that sees consumers preferring natural produce over synthetic alternatives (Ormondroyd and Morris 2019). Yet paradoxically, since the impact of mined crystals, depending on the process applied, can be highly unsustainable, man-made crystals could prove to be a more sustainable option (Abrose 2020). Companies like Sky Diamond (Skydiamond n.d.), who claim to produce carbon-negative diamonds and are extracting carbon out of the sky for their production, is an example. With the free press readily reporting on these findings, particularly in relation to diamonds, and the market segment growing year on year (Danziger 2019), it remains to be seen how this will shift the social construct and its context and, in turn, affect the need for the terminology assigned to be reconsidered.

Examples of Innovations in the Creative Use of Man-made Crystals for Jewelry

Despite all controversy and the limited amount of innovation in the creation of man-made crystals for use in jewelry, they have been incorporated by an increasing number of designers, and have, for some, provided design options that previously would have not been considered feasible and/or acceptable. Some designers have taken liberties with the stones, bypassing "traditional conventions"; for example, by drilling large holes or cutting them in innovative shapes or even enclosing them in unusual materials like rubber. An example is the brand SOMA, whose designer drilled large holes in lower-cost lab-grown CZs to enable them to be hooked on hoop earrings. Another example is the all diamond ring produced by Jony Ive and Marc Newson's cutting the material so it does not need to be set in a metal ring. Other designers, like Karl Fritsch, have used the lab-grown materials in their unaltered, uncut, and unpolished form.

When reviewing the innovative use of man-made crystals in jewelry, two distinct approaches have been determined as most promising for jewelry, and will be investigated in the overarching PhD currently being conducted. The first is the opportunities and liberties certain designers take with man-made crystal materials, likely related to their low cost. Whether it is cutting holes, cutting stones in half, or cutting them in new ways, that would not prove financially viable. These interventions become options for designers due to the currently low cost of some man-made crystals and the large format they can be acquired in. The other is the actual innovation in the material itself, as demonstrated by the new color combinations by Swarovski in their Vibrance collection. With designers like Karl Fritsch incorporating the material in its unaltered state as another example, perhaps with the opportunities for designers to be creative with the material when it is not reproduced to look like what we already know, innovations could be ample.

To date, the latter opportunity has already been explored by setting up a range of crystal-growth experiments in the jewelry studio environment. Even though the crystals being grown are not of gemstone quality (salt, sugar, and alum), the growing of crystals as methodology for the jewelry designer holds great potential (Boons 2021), as it could also be applied to the growing of gemstone-grade crystals in collaboration with partners or upon acquiring specialist equipment. Not unlike the materials used for bio-art and bio-design (Kac 2020; Koivumen 2005; Myers 2012), the growability (Karana and Camere 2017) of crystals, or in other words its ability to be grown in a certain shape or direction, could potentially enable designer to grow crystals in predetermined shapes (see Figures 1 and 2). Crystals grown in a predetermined shape could reduce material loss and cost, and lead to the development of new stone cuts.

Figure 1 (Left): Sugar Crystals Grown in Ring Mold over Eight Days
Figure 2 (Right): Alum Seed Crystals Distributed across a Ring Mold, Suspended in Saturated Solution
Source: Boons

Additionally, the growing of the crystal around designed inclusions (see Figure 3) could also provide aesthetic opportunities. In nature, crystals can contain impurities; often they grew around obstacles in their environment, resulting in inclusions. These are generally considered faults, and only on rare occasions within gemology are they valued. To design them, however, would offer new possibilities to embed patterns and elements, or introduce color and contrast to the crystal.

Figure 3: Various Views of a Grown Single Sugar Crystal with Brass Wire Inclusion
Source: Boons

Further experiments also proved the growing of crystals in a predetermined space in a design—or in situ growth—holds additional design opportunities. When a crystal is grown, control over growing conditions can give the designer sufficient ability to embed the process into the design practice. There are, however, limitations, as not all aspects of the growth can be controlled and a designer will have to approach the methodology as a co-design practice with nature. The individual shape the crystal displays, albeit always similar due to the underlying crystal structure the atoms will align in for each crystal, will still grow in somewhat unpredictable directions (see Figure 4).

Figure 4: Silver Ring with In Situ Grown Alum Crystal from Various Views:
Before-Growth Images on the Left and After-Growth Images on the Right
Source: Boons

As discussed in the paper "Crystals as Co-Creators: An Investigation of Growing Crystals as a Methodology for Jewelry Designers" (Boons 2021), the crystal-growing methodology poses challenges for the jewelry designer who is generally used to being in control of all aspects in relation to the incorporation of stones. Moreover, the delayed process and the additional equipment the growing of gemstone grade crystals requires, which could result in the distancing of the process from the studio environment, are challenges to be investigated further.

Nevertheless, the crystal-growing design methodology (Boons 2021) clearly offers additional opportunities for innovation, and the potential for an alternative and likely more sustainable option to traditional gemstone incorporations. The growing of gemstone-grade crystals is likely to be less sustainable than the growing of alum, sugar, and salt, but the impact of the growth could be analyzed in detail and it is expected to still be more sustainable should stones be able to be grown locally, eliminating the need for extraction practices and transportation.

Conclusion

To complete the cross-disciplinary contextual review on man-made crystals, this paper had to cover a diverse range of sources spanning a number of fields, including gemology, crystallography, humanities, etc. To report on the limited creative use of man-made crystals for the production of jewelry designs, the paper traced the desire for gemstones and their imitations in history and explored the development of the discipline gemology as a means to identify and value crystals. The paper showed that in gemology, man-made crystals are often painted in a negative light. By exploring the terminology appropriated by both mined and man-made crystal companies, a short review of the terminology used to describe man-made and mined crystals was conducted through a critical lens. Key texts investigating the distinction between the natural and artificial were referenced in order to sketch various approaches. Furthermore, although significant innovations in man-made crystals are revolutionizing other sectors (i.e., technology and engineering), the paper aimed to demonstrate that in the jewelry industries, where crystals are used in great numbers, there has been limited creative exploration of these grown materials. The jewelry industry, instead, has only a sparse number of jewelry crystal suppliers taking an interest in growing crystals for the purpose of creative exploration beyond the imitation of mined crystals. Jewelry designs and man-made crystals were reviewed, and a short discussion concluded the paper on how these materials enabled creativity in design. In the overarching PhD research, the design implications, possibilities, and limits of utilizing man-made crystals in the development of jewelry will be investigated. The research will aim to evaluate the possibility and practicality of incorporating the researched man-made crystals and their design process and overarching crystal growing methodology into a contemporary jewelry practice. Furthermore, the terminology used to reference man-made crystals will be fully reviewed in order to identify the need for the reframing and renaming of enhanced and designed crystal materials when used in a contemporary jewelry context.

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