

# IMITATION AMBER BEADS OF PHENOLIC RESIN FROM THE AFRICAN TRADE

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*Examination of contemporary beads with African provenance reveals large quantities of imitation amber beads made of phenol-formaldehyde thermosetting resins (PFs). This article delves into the early industrial history of PFs and their use in the production of imitation amber and bead materials. Attempts to discover actual sources that manufactured imitation amber beads for export to Africa and the time frame have not been very fruitful. While evidence exists that PFs were widely used as amber substitutes within Europe, only a few post-WWII references explicitly report the export of imitation amber PF beads to Africa. However they arrived in Africa, the durability of PF beads gave African beadworkers aesthetic freedom not only to rework the original beads into a variety of shapes and sizes, and impart decorative elements, but also to apply heat treatment to modify colors. Some relatively simple tests to distinguish PFs from other bead materials are presented.*

## INTRODUCTION

Strands of machined and polished amber-yellow beads, from small to very large (Figure 1), are found today in the stalls of many African bead sellers as well as in on-line stores and auction sites. They are usually called “African amber” or “copal amber” despite the fact that many are made from phenol-formaldehyde thermosetting resins (hereafter phenolic resins or PFs). When questioned about the origin of the PF beads, both sellers and collectors indicate a probable European source, possibly German, and likely made during the interwar period. There seems to be no more specific information about them, in comparison to the relatively large amount of detail known about Venetian and other European glass beads that were made for the African trade.

The introduction of PF beads into the U.S. market is documented by Allen (1976:22) who notes that the trend began around 1971, with the “importation of large, attractive, amber-like, oblate-shaped beads from Africa.”



**Figure 1.** Beads of phenol-formaldehyde thermosetting resins (PFs) from the African trade. The large bead at bottom center is 52.9 mm in diameter (metric scale) (all images by the author unless otherwise noted).

He reports that other shapes, such as barrel and spherical (Figure 2), were imported as well, but the short oblates are the most common. Contemporary bead sellers report that these beads are found in West Africa and the Maghreb countries, especially Mauritania and Mali, and in Ethiopia. Allen mentions Nigeria as an additional source, and he also notes “small-sized beads, often found in prayer strand format,” coming from Egypt, the Middle East, and Afghanistan. Allen further comments that “some reputable jewelers and dealers... decided [the imitation amber beads] were Bakelite.” Phenolic resins are often known only as Bakelite®, the original and most recognized trade name for this class of materials. In his pioneering work on identifying materials that imitate amber, Allen (1976) found that over half of the amber-colored beads he tested were a synthetic thermosetting resin. Most likely they were all made from PF.



**Figure 2.** Typical as-manufactured phenolic bead shapes found in the African trade.

The arrival of PF beads in the U.S. coincided with the flood of glass beads from Africa that began in the late 1960s and peaked in the early 1970s (Picard and Picard 1987:4). These beads primarily relate to the heyday of the Venetian and Czech bead industry: the mid-1800s to the mid-1900s. It therefore seems logical to assume, as many did, that the “African amber” beads were roughly the same age.

In fact, the author found one seller of PF beads who attributed them to the late 1800s. Phenolic resins were not produced until 1910 (Crespy et al. 2008), so this claim is incorrect. Two modified natural products – Celluloid (based on cellulose, registered in 1870) and Galalith (based on milk casein, invented ca. 1890) – were used for beads from the late 1800s and into the interwar period. These two early plastics were also used for imitation amber, and since their period of use overlaps with PF up through at least WWII, there is the possibility of confusion among the three materials. The author, however, has not yet found any examples of Celluloid or Galalith beads in the African trade, so the present study is focused on PF beads.

To gain accurate information about “African amber” beads, the author initiated a search for the makers of PF beads, and when and how the beads arrived in Africa. The investigation began with a review of the development of PFs. Industrial chemistry texts, including two by Carleton Ellis (1923, 1935), were very helpful in placing PFs in their historical context as amber imitations and bead material.

## HISTORICAL INFORMATION ON PHENOLIC RESINS

Belgian-born chemist Leo Baekeland succeeded in overcoming the technical difficulties of making solid masses from phenol-formaldehyde combinations and began submitting his inventions, which covered the compositions

and technology for molding PFs, to the U.S. Patent Office in 1907. He was awarded numerous patents, starting in 1909 (Baekeland 1909a, 1909b). Phenolic resin became the world’s first industrial-scale, fully man-made material, following the development of modified natural products such as Celluloid and Galalith.

Phenolic resins are of two basic types: powders with added filler meant for compression molding and casting resins that are poured into open molds and cured without pressure. Unlike thermoplastics, which can be melted and reshaped, phenol-formaldehyde formulations are thermosetting resins that must be machined to final dimensions after curing unless the final shape is produced in the mold. Compression molding compounds are generally designed for industrial uses such as electrical connectors, or items like radio housings. Casting resins were developed alongside molding resins, and are assumed to be the materials used to make beads due to their use as “turnery” materials; i.e., materials designed for machining on a lathe. Castings in the form of rods, sheets, and tubes were the raw stock used to make items like beads and bangles; special shapes like curved umbrella handles were also made by pouring PF resin into lead and glass molds. The castings were hammered out of the lead molds or the glass was broken to remove the article after the cure was complete.

During the period 1905-1910, as Baekeland was conducting research, scaling up his home laboratory production, and opening factories to make his patented Bakelite® resins in the U.S., Germany, and elsewhere, the rest of the industrial chemistry world was not idle. Patent activity in England, Belgium, Germany, and France during the same period shows many inventions for PF formulations (Ellis 1935: Chapter 13) and some are described as “hard translucent resins useable as substitutes for copal, amber, and shellac” (Ellis 1935:287).

Patent applications related to amber and ivory imitations were filed between 1910 and 1912 by Fritz Pollak of Berlin, who disclosed ivory-colored PFs, those with a range of colors from transparent bright red to yellow, and formulations designed to eliminate the rapid color change of PFs once they were exposed to air (Pollak 1911, 1917). In the U.S., Redman (1914) devised ways to improve the toughness of PFs, described their use as artificial amber, and disclosed a method for imparting a ruby-red color to PFs.

An interesting side note to the development of the PF industry is that the worldwide supply of phenol, one of the starting materials required for PF production, was mainly provided by Germany and England prior to WWI (Ellis 1935:359). German chemists were providing expertise

to the factories set up by Baekeland in both England and Germany; being a source of phenol made these countries an obvious choice for new plants. When WWI began in July of 1914, the German chemists in England were evidently sent home, and production of PF resins in the U.S., England, and Germany turned toward providing materials for military use (Holdsworth 2015; Mumford 1924:68-80).

The story of PF resin development picks up after the war ended in November of 1918. In England, the 1919 production of PFs for castings reached one-half ton per week at the Damard plant (Holdsworth 2015) which had entered into collaboration with the U.S.-based Bakelite Co. in 1910 (Crespy et al. 2008). More patents were filed that mention amber substitutes; e.g., one that discloses a method for making multi-colored blocks of PF with amber, ruby red, emerald green, and opaque white layers (Redman et al. 1922). Note that PF patent activity was occurring before the original Baekeland patents of 1909 ran through their 17-year protection period. In Europe, the Bakelite GmbH patent of 1908 filed by Baekeland was invalidated by the 1921 challenge of Pollak (Ullman 1931:4). Ullman also relates that a change of catalysts from those described in Baekeland's first patents allowed an independent German PF resin industry to develop.

The breadth of the PF industry by the mid-1930s is demonstrated by the list of trade names documented by Ellis (1935:1380-1419), one that totals over 300, with over 70 PFs specifically noted as turnery materials, or provided as sheets, rods or tubes, both required by the bead and jewelry industry (Tables 1-4). Product names from Ullman (1931), Baekeland and Bender (1925), and translated *Die Perle* articles (Gumpert and Karklins 2005) were cross-referenced and added if relevant. These lists are provided in the hopes that they will aid further investigation into the history of PF beads.

With such a large number of commercial PFs, the point can be made that it would essentially be impossible to determine the pedigree of any individual PF bead after the fact without significant additional information. The chemical formulas disclosed in patents may provide some basis for distinguishing one PF from another – for example, if a unique element was used – but trade names are not indicated in patents and further historical information about individual products would be needed. It is notoriously difficult to reverse-engineer thermosetting resins in anything but a general way once they are cured and, to make the effort more difficult, it is also likely that many formulations were held as trade secrets. Given this situation, it is easy to see how Bakelite®, the trade name of the first patented PF material, passed into general usage for all PFs.

Another indication of the widespread use of PFs for imitation amber during the interwar period is the law for the protection of natural amber passed by the German Reich in 1934. The law restricted the use of the term “amber” or a word complex that included “amber” to natural amber products with no additives. The cheaper imitation materials were apparently having severe negative consequences for the German amber industry (Ganzelewski 2004:475).

To summarize, phenolic resin production began in 1910 with the founding of the General Bakelite Company in the U.S. After WWI, a large PF industry developed in England and Germany in particular. Building on the pioneering work of Baekeland and others, numerous modifications to the manufacturing process and the chemistry of PFs were disclosed in the patent literature. Some of these materials were optimized for certain properties or applications such as improved machinability or clarity of the final product. The chemical reactions, intermediate chemical species, side-reactions, etc., of these PF formulations are discussed in a very large outpouring of technical literature (Ellis 1923, 1935; Ullman 1931). Amber imitations are mentioned numerous times from the very earliest work on PFs, as there was evidently keen commercial interest in replacing expensive natural amber.

## THE BIRTH OF PHENOLIC RESIN BEADS

Even though PF materials that could have been machined or turned into beads were being manufactured as early as 1910, specific mention of PFs for beads is not found in references until the early 1920s. In Ellis' (1923) text on synthetic resins, beads are specifically mentioned as end products for PFs that were formulated for turnery applications (Ellis 1923:93, 114, 163, 165). Ellis (1923:164-165) has a page on “Infusible Transparent Cast Products from Phenol and Formaldehyde” with sub-headings “Artificial Amber” and “Methods of Making Transparent Products,” both of which mention beads. The products described include “[added] substances such as fish scales and powdered mica to produce a shimmering effect... waxes for the purpose of producing a cloudy amber effect, and dyes of many different colors for producing material suitable for beads and various novelties.”

In the mid-1920s, jewelry made from PFs appears in some publications relating to Bakelite®. Mumford (1924:24) describes “gleaming, cut Bakelite beads of blue or vermillion, or green or purple or amber yellow.” A 1924 color chart showing beads of Bakelite® Pearl Colors and squares of Bakelite® Jewel Quality Colors is reproduced in Davidov and Dawes (1988:17). A Bakelite® Corporation brochure of 1926 shows a triple string of beads (Elfrink 2014).

**Table 1. German PF Trade Names, ca. 1924-1935.**

Utilit (Utilith), Albolit (Albolith)	Augsburger Kunstharz-Fabrik, Augsburg
Pantolit	Augsburger Kunstharz-Fabrik, Augsburg
Resinit (Resinite)	Bakelite GmbH, Berlin
Alberit	Chem. Fabr. Dr. Kurt Albert, Weisbaden
Lor-Wal-Lith	Chemie & Technik J.M.S. GmbH, Hamburg
Dekorit, Leukorith, Vigorith	Dr. F. Rashig, Ludwigshafen
Faturan	Dr. Heinrich Traun & Son, Hamburg (later acquired by Herold AG)
Trolon	Dynamit AG, Troisdorf
Ivorax, Marbolith, Elastolith	Herold AG, Hamburg
Herolith, Ornalith	Herold AG, Hamburg
Taumalit	Isopresswerk, Berlin
Wenjazit	Kunst-Rohstoff AG, Hamburg
Resan, Resanit	Kunstharzfabrik Resan, Mosbierbaum
Koraton	Wedig & Reuss, Eilenburg
Neoresit	Nowak, Bautzen

**Table 2. U.S. PF Trade Names, ca. 1924-1935.**

Gemstone	A. Knoedler Co., Lancaster, PA
Catalin, Prystal	American Catalin Company; later, Catalin Corp., New York
Panplastic	American Plastics Corp., New York
Bakelite, Resan	Bakelite Corp., New York; Bakelite GmbH, Berlin; Bakelite Ltd. Co., Britain; also France, Canada, Sweden, Italy, and Japan
Condensite, Redmanol	Acquired by the Bakelite Corp., New York
Catalazuli	Catalazuli Manufacturing Co., College Point, NY
Ivaleur	Celluloid Corp., Newark, NJ
Dilecto	Continental-Diamond Fibre Co.
Crystillin	Crystillin Products Corp., Brooklyn, NY
Phenolin	DuPont Viscoloid Co., Newark, DE
Marbalin	Federal Cutlery Co., NY
Fiberlon	Fiberloid Corp., Indian Orchard, MA
Textolite	General Electric Co., Schenectady, NY
Durez	General Plastics, Inc., N. Tonowanda, NY
Jewelin	Jewelin Corp., Woodside, NY
Joanite	Joanite Corp., Long Island City, NY
Marblette	Marblette Corp., Long Island City, NY

**Table 3. United Kingdom PF Trade Names, ca. 1924-1935.**

Formite	Bakelite Ltd., formerly Damard Lacqueur Co. Ltd, London
Bexite	British Xylonite Co., Ltd., London
Idonite	Damard Lacquer Co. Ltd., Birmingham
Tufnol	Ellison Insulations, Ltd., Birmingham
Trolone	F.A. Hughes & Co. Ltd., London
Lacrinite	Lacrinoid Products, Ltd., London
Lorival	Lorival Mfg. Co. Ltd., Southall
Metduro	Metduro, Ltd., London

**Table 4. Other European PF Trade Names, ca. 1924-1935.**

Formit, Ambrasit, Ultrasit	Chemische Fabrik Ambrasit, Vienna, Austria
Eolit, Ivoit, Juvelith, Schellit	Kunstharzfabrik Dr. Fritz Pollack, Vienna, Austria
Durolit	Soc. Du Duroid, Enghien, Belgium
Solith	Tschechoslovakische Kunstharzfabrik, Olomouc, Czechoslovakia
Ivrit	Établissement Kuhlmann, Paris, France
Amberglow, Écaille 97%, Similex, Similit	Laboratoires Industriels d'Asnieres, Paris, France
Lucienit	Lucien Eilertsen, Paris, France
Agatine, Nobeline	Soc. Nobel Française, Paris, France
Cristaloid	Unknown, France
Ivrite	Soc. Anon. Ivra, Torino, Italy
Xilite	Unknown, Italy
Haefelyte	Emil Haefely et Cie., Basel, Switzerland
Note: Ambra, Dekufit, Fibroc, Ivorloid, Ronyx, and Tenalan are additional trade names listed in Ellis (1935) and Gumpert and Karklins (2005) with no identifying business name or country of origin.	

An obscure German jewelry trade journal from the 1920s, *Die Perle*, was fortunately discovered, reviewed, and select articles translated by Gumpert and Karklins (2005). There are specific mentions of PFs developed for beadmaking. A 1924 article describes a new German PF material, Utilit, with “a rich scale of colors, from transparent to vivid red,” for “use in manufacture of beads,” and another the same year mentions additional materials – Dekorit and Leukorit – for the manufacture of beads. Dekorit is listed as an “amber substitute” in Ellis (1935:1391). Juvelith, the “synthetic material that most resembles amber,” was also reported in 1924. In 1926, *Die Perle* introduces Vigorit, which has “greater solidity and stability of colors when exposed to light,” and Dekufit (manufacturer unknown, possibly related to Dekorit) “which is available in all imaginable colors and

is well-suited for beads and other products.” Tables 1 and 4 provide more details about these products.

The firms that manufactured PF as raw stock and turnery material likely did not manufacture beads. In the excerpts from *Die Perle*, there is an advertisement for a company called Sächsisch. Kunsthorn-Industrie, based in Neukirch (Lausitz), with the notation, “*Perlen, Colliers, Knoepfe aus Galalith und imit. Bernstein fabriziet als Spezialität*,” or “beads, necklaces, buttons of Galalith and imitation amber fabricated as a specialty” (Gumpert and Karklins 2005:20). It should be noted that Galalith was also used as an amber substitute, so mentioning Galalith *and* imitation amber strongly suggests that materials other than Galalith, such as PF, are indicated.

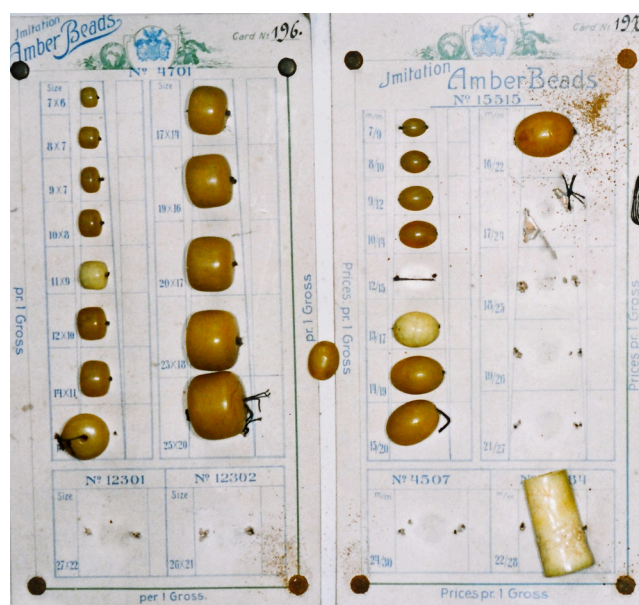
The conclusion drawn from the foregoing information is that PF imitation amber suitable for beads, and possibly developed specifically for beads, was in use by the mid-1920s. Phenolic resins were being produced in the U.S. and all over Europe, especially in Germany and England. Additionally, imitation amber beads were certainly being made from PF for the costume jewelry trade in the interwar period, but no references were found regarding the production of PF beads specifically for trade to Africa during that period.

### PHENOLIC RESIN BEADS FOR THE AFRICAN TRADE

When starting this investigation, the author hoped to find dated bead sample cards – one of the gold standards of trade bead research – showing the various PF beads found in today’s collector’s marketplace. Unfortunately, most of the cards encountered only exhibit beads made of glass or ceramic (e.g., Neuwirth 2011: Plate 25B). Two notable exceptions are cards labeled “Imitation Amber Beads” that bear the logo of the Sachse Company, a well-known jewelry and bead export firm that operated in Jablonec nad Nisou, Czech Republic, from the late 1800s until 1920, when the business was sold. Albert Sachse developed a significant export trade to West Africa (Kaspers 2014:45), so the beads on the sample cards have a very high probability of entering the Africa market during the first two decades of the 20th century.

Held by the Museum of Glass and Jewelry in Jablonec nad Nisou, the cards show mostly medium-brown beads, with a few ivory-colored specimens (Figure 3). The brown beads look similar to short barrel-shaped PF beads found in today’s African trade, but they are brown rather than amber yellow. It is possible that they are PF beads that have discolored over the years, but Celluloid and Galalith are also distinct possibilities (Jiroušková et al. 2011:11). Unfortunately, since the author has not been able to personally examine the cards and requests to the museum regarding them have gone unanswered, the composition of the beads remains uncertain.

It is not known to what degree PF beads were manufactured during the war years. Though small-scale glass beadmakers did operate in rural Germany until 1942 (Vierke 2006:417), it is likely that the plastics industry was soon set to producing materials primarily for the war effort, especially since the National Socialists considered the bead industry a “nonsense industry” that produced “racially intolerable Negro jewelry” (“*Mumpitz-Industrie... rassistisch nicht tragbaren Negerschmuck*”) (Karlis Karklins 2014: pers. obs., Historisches Museum Bayreuth “bead room” exhibit text). While the German glass bead industry



**Figure 3.** Sample cards of “Imitation Amber Beads” from the Sachse Co., Czech Republic, ca. 1920s (photo: John Picard).

recovered quickly after 1945 (Vierke 2006:136), it is not known if the PF bead industry did as well.

An article by Günther Kuhn (2002) provides support for the post-war German production of PF beads for the African trade. It contains a photo from 1951 that shows strands of very large, presumed PF beads, on their way to Sudan via Tangier by air, for use as *Bernsteingeld* or amber money. The beads are mostly short cylinders, up to about 50 mm in diameter, with some much smaller beads that could be short oblates. Kuhn’s father bought two strands of similar beads from Bernstein-Manufaktur Hamburg in 1952. The author believes the beads are made of PF, based on Kuhn’s description of how the color of the beads has changed over the last 60+ years from yellow-brown to dark coffee brown. Age-related browning is a well-known trait of PF resins (see below).

A memo sent to Kuhn’s father by Bernstein-Manufaktur Hamburg on 22 February 1952 reveals that PF beads were more affordable than natural amber:

We cannot deliver a bunch of *Negerkorallen* [Negro coral] from natural amber or pressed amber for a price of DM 10 even if we deviate from the standard weight of 320 grams. We recommend, however, a bunch of *Edelkunstharz* [a German term for cast PF; literally, precious art resin] in amber color, which certainly serves the same function as a showpiece for your collection (Kuhn 2002:24) (translated from German by the author).

Based on Kuhn's report, PF beads were traded into Africa as imitation amber after WWII and were a viable product due to the high price of natural amber. The Hamburg connection was a dead end for further details in that the firm that bears the name Bernstein-Manufaktur today is a completely different company than the one that sold beads in 1952 (Bernsteinmanufaktur Hamburg 2015: pers. comm.). But a link to Königsberg was discovered when information was received naming Gerhard Rasch, a former manager of the Bernstein Manufaktur-Königsberg operations that were relocated to other parts of Germany due to the war, as the founder of the original Bernstein-Manufaktur Hamburg in 1945 (Günter Kuhn 2015: pers. comm.). Kuhn followed many leads but could not find anything else about the manufacture of the (presumed) PF beads his father purchased.

Saechtling and Küch (1951) discuss a rising post-WWII demand for *Edelkunstharz*. This "precious art resin" has the same triboelectric properties as amber (i.e., it takes on a static charge when rubbed) and so passes the electrostatic test used by the customer for amber. The implication is that the buyers believed the material was natural amber. The intended trade was to Africa, as indicated by its use as *Negergeld* (Negro money) and *Negerschmuck* (Negro jewelry). They also reveal that real amber from East Prussia was no longer available for this purpose.

PF stock and beads continue to be made. For instance, the website of the Raschig company based in Jaipur, India, offers "original German Catalin and Faturan" made at factories in Germany, India, and Thailand ([www.raschig.net](http://www.raschig.net)). Their site is linked to CatalinRods.com, a subsidiary based in Thailand, which produces beads and rosaries using "genuine cast phenolic resin [that] has the same chemical, physical, and optical properties as vintage made phenolic resins" (CatalinRods.com 2009: About Us). It is highly likely that their products are among the new PF prayer strands that are currently readily available from online auction sites. Whether such contemporary PF beads have found their way into Africa is unknown.

The above sources provide evidence that the PF beads we see today in the African trade could have been produced and introduced after WWII, especially since some of the capacity of the German PF industry was restored by the new Bakelite GmbH plant in Iserlohn-Letmathe in the early 1950s (Wikipedia 2016). There is, of course, the possibility that some of the beads traded after WWII were either pre-war products or made from pre-war stock (Karklins 2016: pers. comm.). The Sachse sample cards are likely evidence of PF beads for the African trade prior to 1920. More research is needed in order to establish links between PF bead manufacture and the African trade during the interwar period.

## PHENOLIC RESIN BEADS IN TODAY'S AFRICAN TRADE

PF beads are easy to find at a variety of venues, although in the past seven years the author has noticed that the availability has dropped and the prices have increased correspondingly. These beads are rarely marketed as phenolic resin. Instead the terms "African amber" and "copal amber" are in wide use as generic terms not only for PF beads but also for other imitation amber beads such as those made from thermoplastics, dyed horn, etc. The term "copal amber" is especially unfortunate since it is a meaningless term – a substance is either copal or amber. Allen (1976) relates how "copal amber" or "so-called copal" was represented as "amber from Africa" and that "many people forgot their fears that African amber was plastic" in continuing the misidentification.

The term "copal amber" also appears in the section on Natural Beads in a booklet by Gordon and Kahan (1976). Their sketch of a "copal amber" bead looks very much like a short, oblate PF bead, complete with a typical pattern of long, sparse cracks, such as seen on the largest bead in Figure 2. It is the author's opinion that their "copal amber" beads are actually made of PF, based on the range of colors noted (golden yellow to deep red or warm brown), the opacity (opaque or partially transparent), and the surface cracks (Figure 4). Regardless, it seems that a new term, "copal amber," arose around the time that PF beads from



Figure 4. Color variation and marbling in PF beads from Africa.

the African trade were appearing in U.S. markets. One can speculate that whether or not people realized the beads were of man-made thermosetting plastic, instead of calling them “imitation amber,” “synthetic resin,” or another more accurate term, the term “copal amber” was invented, perhaps as a marketing tool.

A few distinct shapes and sizes of PF beads are seen repeatedly in African trade strands: short oblate, cylindrical, and round (Figure 2), with short oblates 30-40 mm in diameter especially numerous. The shapes and quantities suggest machining and polishing on a mass-production scale, presumably using rod stock of standard sizes. Based on the number of beads the author has seen for sale in various venues, it would appear that tens of thousands of these beads were made.

Phenolic resin is much harder, more rigid, and more durable than the natural amber it imitates. Artisans in Africa have taken advantage of these traits to rework the original beads into beautiful and sometimes intricate works of art (Figure 5). The simplest modification is cross-drilling (drilling a hole perpendicular to the original one) which allows the beads to be worn flat. A second common modification is reshaping cross-drilled beads into soft diamond shapes, a traditional shape found in Africa among real amber beads.

Diamond and other bead shapes are found with scribed lines and circles, as well as pigmented dots. Finally, flat pieces that were likely sawn or broken from thick beads, or taken directly from rod stock, are perforated and fashioned into openwork designs (Figure 6). Many of these altered PF beads come from Mauritania where they are used as ornaments woven into women’s hair (Christine Smoot 2015: pers. comm.) and in traditional necklace designs.

PF beads are also found with patterns of small dots as well as larger irregular areas that were made by burning the surface, presumably with a hot point in the case of the former and a small flame (cigarette lighter perhaps) for the latter (Figure 7). This figure also shows PF beads with smooth concave pits, also presumably applied for decorative purposes, and several beads that exhibit characteristic cracks that serve as “natural” decoration.

## IDENTIFYING PHENOLIC RESIN BEADS

As previously discussed, Galalith, Celluloid, and a number of completely synthetic polymers have been used as amber substitutes (Gierlowska 2003). A few African trade beads are made of high impact polystyrene, polyester, and dyed horn. Aside from the analytical laboratory, there are

ways to confirm that a bead is made from a PF, using easily obtained equipment and chemicals. One consideration that needs to be kept in mind when examining PF beads is that many formulations of phenol and formaldehyde were made into commercial products and a range of properties can be expected. Exactly how the specific formulations affect the final properties of PF beads would require analytical instrumentation and samples of known composition.

## Color Instability

The early PF literature reveals that formulations had unstable color, a distinguishing feature of this material that can help with identification. PF products made in a mold in light colors darkened to red and brown with exposure to ambient conditions. The color change in some cases occurred within a few weeks to a month (Ellis 1935:335; Ganzelewski 2004:477). Some patents disclose ways to eliminate the problem, including the obvious but highly impractical fix of excluding oxygen (Redman et. al. 1920). Reducing excess phenol or using purified phenol are methods also disclosed in patents (Hessen 1931; Pollak 1917). There are mentions of special formulations to enhance color stability via more expensive starting materials when cost was less of a problem as, for example, for jewelry applications (Ellis 1935:326). The color stability problem of PFs was still being tackled in the 1960s as shown by an invention that used glyoxal to prevent or delay the color change in PFs (Feigley 1961).

The color change is attributed to unreacted excess phenol or impure raw materials or catalysts, all of which lead to the development of chemical compounds that gradually oxidize to dark colors (Ellis 1935:335). The red color, often called cherry red, is due to the presence of aurin, a chemical that is bright red at a pH over 6.8. Aurin is one of the possible condensation products of phenol and formaldehyde (Ellis 1935:294, 312). Translucent beads for costume jewelry that have this distinctive color are normally called “cherry amber,” another notable conflation of natural and synthetic material terminology.

The PF material with the trade name Faturan (Table 1) deserves special mention with regard to color instability. Holdsworth and Faraj (2015) state that Faturan has the unique characteristic of “always oxidizing to a dark red” regardless of the original color. They dissected a dark red shift knob and revealed that the material beneath a thin outer layer of cherry red was comprised of amber yellow and green PF. Faraj (2016: pers. comm.) has further experimented with making new beads from old pieces of Faturan (from a contact who has mined a defunct factory site for pipe mouthpieces and umbrella handles) and observed the red color developing on the surface in a matter of weeks.



**Figure 5.** Modified oblate beads and smaller pieces of PF beads from Africa. Remnants of the original and cross-drilled holes are visible on some beads.



**Figure 6.** Carved, drilled, and decorated PF beads from Mauritania, Mali, and Morocco. The center bead, top row, and the two right-most beads, third row, show added red and blue pigment.



**Figure 7.** PF beads from Ethiopia showing a variety of surface modifications.

Since a large number of formulations of PFs were developed in the same time frame as Faturan (the earliest reference found by Holdsworth and Faraj is 1917), and many patents sought to overcome the problem of relatively rapid color changes in PFs, it is possible that Faturan is not the only product that manifested this behavior. Additional research on early commercial PF formulations is needed for clarification.

The reaction that spontaneously turns some PF resins dark red at room temperature may be accelerated in other, more color-stable PF resins by heating them to temperatures of 121-177 C for short periods of time. The surface color will progressively change from the original amber yellow to red to dark reddish brown to almost black. This accelerated color change confirms the composition as PF; the color is irreversibly changed, however. The heat treatment of amber-colored PF beads to effect color changes was reported by Allen (1976:26) and has been repeated by the author (Falabella 2015a, 2015b). A typical result of heating a PF bead to temperatures of 121-177 C is shown in Figure 8.

Red and red-brown PF beads are found among the amber-colored beads in the African trade (Figure 9). The color could be due to the use of the type of PF that changes color under ambient conditions, but in all probability it is



**Figure 8.** PF bead subjected to elevated temperatures in air (right) compared to an unheated one (left). Thermal cycle was 1 hour at 121 C, followed by 1 hour at 149 C, followed by 1 hour at 177 C.



**Figure 9.** Heat-treated PF beads from Africa. Note that some beads have been reshaped as well as heat treated.

the result of a heat treatment applied by the African owners. One color-altering technique reportedly employed in Africa is heating in palm oil (John Picard 2015: pers. comm.), presumably to help avoid thermal gradients and the resulting stresses that can break the bead (a bead heated by the author to about 232 C in air broke in half).

### Identification Tests

Relatively simple tests that do less permanent damage than heat treatment can be employed to identify PFs. Unfortunately, none are completely non-destructive and some require a keen sense of smell. In general, the author uses visual inspection of PF beads to identify them, and confirms the composition with other tests if necessary.

PF beads often have surface cracks that are indicative of the very slow shrinkage of the material over time or of heat treatment. The cracks appear as dark lines on several beads in Figures 1, 2, 6, and 8. Such cracks do not appear in all PF

beads, however. As with some of the other properties of PFs, the presence or lack of cracks may be due to differences in chemical formulation rather than age or exposure conditions.

The surfaces of many amber-colored PF beads turn shades of yellow-brown to brown with age (Kuhn 2002). This change is distinct from the red color that results from heat-treatment or from a PF composition that is intrinsically unstable. That the brown color exists in a thin surface layer can be seen on beads where the layer has been worn away by rubbing on adjacent beads (Figure 10). This layer cannot be washed off, showing that it is not a patina resulting from contact with skin oil and dirt. It can, however, be rubbed off and the original color restored. The gradual browning of the surface of PF jewelry items is well known by vintage Bakelite® jewelry collectors. After studying the chemistry of the degradation of PFs, the author believes the brown color is either due to: 1) the oxidation of small amounts of free phenol on the surface (the oxidation products of phenol are varied and include highly colored compounds such as benzoquinones), or 2) the breakdown of cured PF into colored aromatic compounds.

The brown surface of old PF beads will often, but not always, give a positive reaction to being touched with a cotton swab wet with a tiny amount of a 10% ammonia solution. The swab will turn dark mustard yellow. A reaction with free phenol or one of the oxidation products

of phenol is presumed but not proven and would be an interesting investigation. Ammonia-containing products such as Simichrome® (a metal polish made in Germany) are commonly recommended in the vintage plastic jewelry trade to confirm old PF articles. Since Simichrome® contains a mild abrasive, using it for spot testing may remove some of the surface layer. Products such as Purple Power® that contain sodium hydroxide will also give a positive test. The author has found that red heat-treated PF beads do not give a positive result, presumably because the reactive compounds on the surface have evaporated or degraded.

Determination of the density of a bead by weighing, then determining the volume by water displacement, can be useful to distinguish PF (specific gravity 1.35-1.38 g/cc) from amber (1.05-1.10), polystyrene (0.96-1.05), and acrylic (1.17-1.20). But the density of PF is too close to polyester (1.38), Celluloid (1.4), Galalith (1.35), and possibly some epoxy resins for this physical property to be definitive.

A favorite test of the author is the use of a diamond-grit bead reamer to remove some material from the surface of the perforation (this assumes the perforation is not coated with dirt which must be removed). If the resulting dust is sniffed immediately, the musty, medicinal odor of phenol (also known as carbolic acid, an old disinfectant) can be detected if the bead is made from PF. The dust will typically be a mustard yellow color, regardless of the outer surface color. Other plastics, like acrylic and polystyrene, have a distinct plastic odor. Galalith, which is based on the milk protein casein, yields dust that smells like burnt milk and Celluloid dust smells like camphor. Dust from horn beads may smell faintly like burned hair. Natural amber dust has a pleasant pine odor.

The smell test may also be done by touching a red-hot needle point to the bead. A spot just inside the hole is the least intrusive. The hot needle will readily sink into all thermoplastic materials and amber, but not into PF, Galalith, or horn. This test must be approached with caution as it involves the risk of inhaling potentially toxic fumes, and Celluloid is very flammable. Some amber-colored PF beads collected by the author have small, dark burn marks that were probably hot-point tests used to prove that the material is PF and not natural amber or thermoplastic. Running very hot water over a bead until it is heated up can also give a positive result in the smell test, but this treatment can remove patina.

## CONCLUSION

The year 1910 has been established as the start of industrial production of phenol-formaldehyde resins and therefore, the earliest possible date for beads made of this material. By the early to mid-1920s, many PF products



**Figure 10.** PF beads showing age-related surface browning with the original color visible at wear spots around the perforations.

for imitation amber articles and beads are discussed in the literature, and by the mid-1930s, over 70 commercial product names exist for PF materials suitable for beads. Despite strong circumstantial evidence that imitation amber beads were probably made for the African trade in the first few decades of PF production, no firm documentation has been found to support this. Importation of PF beads into Africa during the early years of WWII is a possibility and seems to have revived in the post-war period. Circumstantial evidence points to Germany as the probable place of manufacture.

When PF beads came on the U.S. market around 1970, the widespread use of the terms “African amber” and “copal amber” for them appeared to be the result of the original marketing of the beads as a substitute for natural amber, or possibly as a form of genuine natural amber or copal. The same terms persist in today’s market, not only for PF beads, but for beads made of other synthetic materials.

More work is needed to establish the earliest dates and manufacturing sites of PF beads found in the African trade. It is hoped that bead historians and researchers in Europe in particular will find this report helpful in the event they find relevant information about PF beads in their respective locales.

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