Porcelain

Pottery has been made since Neolithic times, when people in agricultural communities fashioned vessels for cooking and storage. Wet clay is plastic and can be molded into any desired shape, but when baked, the clay is remarkably resistant to weathering and other agents that corrode metal or destroy organic materials. Early potters found techniques to make their art even more durable, by using different types of clays, adding other materials to the mixtures, and developing new methods for firing. One of the most sophisticated forms of pottery is porcelain.

Porcelain is one of the hardest ceramics.

Porcelain is a vitrified pottery with a white, fine-grained body. Other earthenware is porous, opaque, and coarse, but porcelain is often translucent. This translucency, as defined by Western practice, is what classifies a material as a porcelain. The Chinese, however, define porcelain as any pottery that is resonant when struck. Most porcelain is white, although some has a gray or dusky appearance. Because it is one of the hardest ceramics, porcelain is now used for laboratory equipment and electrical insulators

Crude porcelain was first made during the T'ang dynasty in China at about the 7th century A.D. Known as true, or hard-paste, porcelain, it was fashioned out of *kaolin* (a pure white clay formed when the mineral feldspar breaks down), mixed with *petunse* (a feldspathic rock found in granite), and ground into powder. The mixture was fired at an extremely high temperature of 1450°C (2650°F), which caused the petunse to vitrify; the refractory kaolin, however, allowed whatever figure was fashioned to retain its shape. Because it was extremely difficult to maintain an even heating distribution throughout the entire kiln, the temperature rose so high in many initial attempts that even the clay vitrified.

The early discovery of porcelain was probably an accident, an offshoot of Chinese stoneware manufacture with the serendipitous addition of ground white rock (petunse) and white clay (kaolin). The proportions of kaolin and petunse vary. "Severe" porcelain has a higher percentage of kaolin, making it appear harsh and cold, while "mild" porcelain has a lower percentage of kaolin, resulting in a mellow, satiny appearance.

During the Sung dynasty (960 - 1279) royal factories began producing porcelain for the Imperial palaces. Since the 14th century, most Chinese porcelain has been made in the city of Ching-te-chen.

Although porcelain manufacture had spread to Korea by the 1100s and to Japan by the 1500s, the Chinese guarded their secret for many centuries. A Persian traveler to Egypt wrote an account describing the Chinese porcelain he had seen; his report circulated in Italy and caused much interest. Marco Polo also described Chinese porcelain, and items of exported pottery made their way along the trade routes. In 1171 the Egyptian Sultan Saladin presented the Sultan of Babylon with a gift of 40 pieces of "China ware," which was described by returning Crusaders.

Italian princes, fascinated by the objects, had porcelain imported from China by returning mariners. The new fad of drinking coffee, tea, and chocolate in the 1600s created an enormous demand for fine porcelain cups and saucers. Under royal patronage, alchemists tried to discover how the material could be manufactured, but without chemical analytical methods, success came only through trial and error. One Venetian alchemist, Maestro Antonio, expended much effort in concocting porcelain, while other records tell of partial success by a craftsman in Ferrara.

Others found a way to make glass translucent, and hence similar to porcelain, by adding tin oxide—but it was impossible to form intricate glass shapes by using the simple methods available to potters. It was perhaps inevitable that someone would try a mixture of clay and ground glass. On firing, this resulted in a pseudo-porcelain, called "soft-paste." Soft-paste porcelain was made with a mixture of clay and ground glass, which required a relatively low firing temperature of 1200°C (2200°F).

Soft-paste porcelain is similar in appearance to true porcelain, but the material is much softer—it can be cut with a file and is much more difficult to clean, whereas true porcelain cleans easily and does not scratch.

The first European soft-paste porcelain was created in 1575 under the sponsorship of Francesco I de'Medici in Florence, although more than another century would pass before it could be manufactured in quantity. The French also produced soft-paste porcelain at Rouen and St. Cloud in the 1600s. In 1673 the noted faience maker Louis Poterat received a royal "privilege" for making soft-paste porcelain and produced mustard pots, salt-cellars, and large vases. (Faience is earthenware decorated with opaque colored glazes.) Within a century, other French porcelain works were established at Chantilly, Mennecy, Vincennes, and Sevres. In England, soft-paste porcelain began to be manufactured by establishments at Chelsea, Bow, and Derby during the mid-1700s.

The secret of true porcelain was not discovered in Europe until 1707 by the mathematician Walter von Tschirnhaus and the alchemist Johann Friedrich Böttger, both employed by Augustus the Strong of Saxony (actually Böttger was kidnapped and forced into the position). Augustus the Strong's fascination for collecting Oriental porcelain nearly bankrupted his kingdom. While previous European efforts had focused merely on reproducing the characteristics of Oriental porcelain, Tschirnhaus and Böttger used their alchemical skills to do crude scientific analysis. Tschirnhaus recognized that true porcelain must be a mixture of natural earths, and he and Böttger concentrated on this line of investigation. They substituted ground feldspathic rock for the ground glass used in soft-paste porcelain; they used local kaolin as the base clay.

Tschirnhaus had begun his experiments about 30 years earlier, using enormous burning glasses to study the effects of red-hot temperatures on various materials. He and Böttger used their researches to establish a profitable earthenware industry in Saxony, but they still desired to reproduce true porcelain. The pair ordered samples of clay from various parts of the kingdom, which finally resulted in their realizing the advantages of using kaolin clay. Tschirnhaus and Böttger established a true porcelain factory at Meissen, near Dresden, in 1707, but Tschirnhaus died a year later. The first major porcelain sales took place at the Leipzig Fair in 1713.

The newly discovered technique spread from factory to factory, and soon European porcelain works made elaborate dinner services, tea and coffee services, and delicate figurines. In the 1770s, the discovery of kaolin allowed the French to make true porcelain in their Limoges and Sevres factories, which eventually replaced the soft-paste work. Competition from Sevres, as well as internal political disorder, drove the

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German porcelain works into decline during the late 1700s.

A third type of porcelain was discovered in England in 1797 by Josiah Spode II, who added the ashes of ox bones to the known hard-paste porcelain formula. This became known as bone china, and is superior to true porcelain in that it does not chip as readily.

The superiority of true porcelain and bone china rapidly caused the discontinuation of soft-paste manufacture. Kiln wastage of soft-paste porcelain sometimes reached 90%, and the finished product still shattered easily. True porcelain also chips rather easily because of its vitreous nature, and it often carries a blue or gray tinge. For these reasons, bone china—which does not chip easily, is strong, and (because of the bone ash) has a pure ivory-white appearance—is often preferred in England and the United States.

The porcelain industry has grown to encompass major mass-production techniques worldwide. Even after thousands of years of use, new porcelain formulations continue to be developed, displaying a wide range of material characteristics for specialized applications.

KEVEN J. ANDERSON □

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