

LOW TEMPERATURE SYNTHESIS OF VITREOUS BODIES AND THEIR INTERMEDIATES

CROSS REFERENCES OF RELATED APPLICATION

This application is a continuation-in-part of copending application, Ser. No. 827,725 filed Aug. 25, 1977 now abandoned.

FIELD OF THE INVENTION

This invention relates to a novel method for making a vitreous body and its intermediates. More particularly, the method relates to a low temperature production of a vitreous body via synthesis of a self-supporting body by solution deposition.

DESCRIPTION OF THE PRIOR ART

In recent years, the most commonly employed commercial process for the manufacture of glass is the direct melting process. This process is somewhat tedious and has not been very successful in the melting of easily devitrifiable and high refractory glass. Many of the latest technological advances demand glass to be in a state of high purity which is seldom met in a direct process. Operational cost of the direct process is energy-sensitive and recurring energy crises continue to have significant impact on glass making operations. Consequently, a method for preparing glass at low cost, in a state of high purity and in relatively unlimited composition is needed.

A number of indirect processes, namely, anodization, shockwave treatment, and neutron bombardment, have been proposed, but their use has never been realized on a large scale. These processes severely limit the operational flexibility and in most cases, the production cost is higher than for the direct process.

In U.S. Pat. Nos. 2,480,672, 2,106,744 and 3,785,793, for example, a process is disclosed wherein the silica content of an easily meltable alkali-borosilicate glass is enriched by phase separation and leaching. The porous glass which is obtained as an intermediate product is thermally consolidated at elevated temperature. Although the process is comparatively inexpensive, it suffers from the limitation with respect to choice and regulation of glass-forming compounds. Choice and regulation of modifying compounds can, however, be achieved via a doping operation in the pores of the porous glass. Physical doping operations are disclosed, for example, in U.S. Pat. Nos. 2,336,227, 3,232,782, 3,938,974 and in the Ph.D. Thesis of M. Samanta, "Molecular Engineering of Silica-rich Glasses Produced by Phase Separation," Catholic University of America, 1975. A chemical doping process is disclosed in a pending application, Ser. No. 832,230 filed Sept. 12, 1977 by M. Samanta.

High purity glass has been prepared by a vapor deposition process as described, for example, in U.S. Pat. Nos. 2,326,059, 3,884,550 and 4,062,665 among many others. In such a process vitreous silica is deposited in the form of a self-supporting porous body singly or in combination with a dopant. This process is expensive and the shape of bodies obtainable from such a process is limited.

Polymerization processes have been tried for glass making with limited success. Two distinct lines of approach have been attempted. First is the concentration of a colloidal solution under controlled conditions as

described, for example, in U.S. Pat. Nos. 2,886,404 and 3,535,890. Second is the interaction in solution between a silicon compound and a polymerizing agent therefor, as described, for example, in U.S. Pat. Nos. 3,678,144, 3,827,893 and 4,059,658. The main difficulty in both lines of approach is the large shrinkage accompanying the process which makes the glass susceptible to breakage and which presents a potential problem in the design of molds.

SUMMARY OF THE INVENTION

In the process of the present invention, first and second solutions separated by a permeable barrier are provided. The first solution contains at least one basic or alkaline glass forming solute and the second solution contains at least one acidic solute with the permeable barrier being substantially permeable to the acidic solute but substantially impermeable to the basic solute. When the first solution and the second solution are originally at suitable concentrations, passage of the second solution through the barrier occurs and a chemical combination takes place resulting in the deposition of a porous self-supporting body on the side of the barrier in contact with the first solution. The porous body can be purified, dried and thermally consolidated to a non-porous glass.

DETAILED DESCRIPTION OF THE INVENTION

The present invention facilitates an economical mass production of vitreous bodies in a state of high purity and in virtually unlimited shapes. According to this invention, a porous self-supporting body deposits on a substrate, when a first solution containing a suitable concentration of at least one basic glass forming solute is allowed to react, on the substrate, with a second solution containing a suitable concentration of at least one acidic solute. When the concentration of the acidic solute in the second solution falls outside the range of suitable concentrations, amorphous or crystalline particles result with no interconnectivity. The broadness of the range of appropriate concentrations depends on the particular type of reaction and can be determined experimentally by trial and error. The first solution and the second solution are separated by a permeable barrier the walls of which act as a substrate for deposition of a porous self-supporting body. The second solution is diffused through the barrier which is substantially permeable to the acidic solute but substantially impermeable to the basic glass forming solute. This assures a reaction between the first solution and the second solution on the barrier to deposit a porous self-supporting body.

The nature and composition of the solutions which are useful for glass formation are shown in Table 1 (first solution) and Table 2 (second solution). The solutions may be binary (containing one solute) or multicomponent (containing more than one solute). The solvents useful for the purpose of making a solution may be water, hydrocarbons such as benzene, alcohols such as methanol, ketones such as acetone, ethers such as diethyl ether, carboxylic acids such as acetic acid and mixtures thereof.