Diamond Windows for Withstanding Very High Pressures

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Diamond windows have been tested out and found to withstand much greater pressures than glass or fused quartz windows (up to 21,500 atmospheres), particularly when water and alcohol solutions are used to transmit the pressure to the windows.

PROCEDURE AND RESULTS

NO HIGH pressure window up to the present time has been successfully constructed to withstand a pressure of more than 30,000 atmospheres, and then, only when the transmitting medium is a light paraffin oil or some similar material. If a material such as alcohol, water or ether is used to transmit the pressure the windows are usually fractured between 4000 and 8000 atmospheres.

This difficulty has in some cases been overcome by placing the above named liquids in a small collapsible or telescoping cell which is fitted at each end with a glass window through which one may make his observations.[1] The pressure is then transmitted to the cell by paraffin oil. Thus, the liquids which break the windows easily do not come in contact with those windows which support the pressure. By this method alcohol, ether, or water, and solutions in which these liquids are used as solvents can be observed up to 30,000 atmospheres.

The method of using a small cell inside the pressure cylinder is not completely satisfactory because some of the liquid in the cell may escape and come in contact with the pressure windows thus causing them to break. Another disadvantage in using such a cell is the fact that after the pressure has been built up to 10,000 atmospheres, or higher, and is then released, the inner surface of the cell windows are frequently fractured while in most cases the side of the window in contact with the oil is not injured. In some experiments carried out in this laboratory it was shown that diamonds showed no tendency to fracture when subjected to such conditions. This led us to believe that diamond windows should be very effective as pressure windows even though the medium used to transmit the pressure be one of those that readily breaks glass or fused quartz.

The diamond used in this investigation was 3 mm thick and 3.5 mm in diameter. It was mounted on a hard steel support polished to a mirror surface over a hole 1.5 mm in diameter and held in place in the usual manner by a small amount of liquid balsam.

[1] Thos. C. Poulter, Phys. Rev. **40**, 860 (1932); Thos. C. Poulter and Robert O. Wilson, Phys. Rev. **40**, 877 (1932); Thos. C. Poulter and Carl A. Benz, Phys. Rev. **40**, 872 (1932).

The diamond window was then surrounded by water and subjected to a pressure of 21,500 atmospheres. When the window was removed from the cylinder it was not damaged in any way. Since 21,500 atmospheres pressure is more than that necessary for the formation of ice VI, the diamond window was surrounded by a 50 percent solution of ethyl alcohol. A pressure of 21,500 atmospheres was applied. At this pressure the cylinder which contained the diamond window ruptured, thus releasing the pressure instantaneously but without damage to the diamond window.

Another cylinder was used in an attempt to test the diamond window to still higher pressures but this cylinder ruptured at about the same pressure. The diamond window used in these tests has been under pressure more than twenty times and in three cases the pressure has been released suddenly by the splitting of the cylinders. Since these windows show no ill effects from the tests which we have made thus far, it is the belief of the authors that such windows will prove very valuable in the field of optical studies at high pressures.