Diamond Anvil Cell Encyclopedia Article

Diamond Anvil Cell

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Diamond Anvil Cell

Interest in high pressure phenomena peaked during the 1880s. The French scientists Louis Paul Cailletet and Emile Hillaire built devices for studying the behavior of materials under pressures up to three thousand atmospheres (44,000 pounds per square inch). Their devices failed at about three thousand atmospheres, however, and a limit to such research seemed to have been reached. Two decades later, however, a new approach was tried. Percy Bridgman, then a doctoral student at Harvard, designed a new device for creating high pressures. Bridgman's first diamond anvil cell was able to produce pressures four times greater than those achieved by Cailletet and Hillaire. Further refinements over the next fifty years resulted in cells that could produce pressures of thirty thousand, fifty thousand, and eventually one hundred thousand atmospheres. In some specialized situations, the cell was modified to produce pressures of 425,000 atmospheres (6,250,000 pounds per square inch). The diamond anvil cell is a small device that can easily be held in the hand. It consists of two pistons with very different surface areas, A1 and A2. A1 can be as large as a few square centimeters while A2 is about 0.1 square millimeters. When a force is applied on the large surface area by turning a screw, that force is multiplied on the smaller surface area by a factor of A1/A2. The sample to be studied is placed between two flat parallel plates made of diamond in the smaller piston. Diamond is chosen for the plates because it is the hardest substance known and it is transparent to light. Thus, the experimenter can watch what happens to the sample as pressure on it is increased. One application of the diamond anvil cell is simply to observe changes in the properties of a substance at high pressures. For example, the cell has been used to convert hydrogen to a metallic solid at pressures of fifty-seven thousand atmospheres (840,000 pounds per square inch). Geologists also use the cell to simulate pressures within the Earth's core and to test hypotheses about the deepest regions of the Earth. Finally, the cell has been used to convert graphite to synthetic diamond at pressures of sixty-five thousand atmospheres (960,000 pounds per square inch) and temperatures of about 1400° C.