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MODIFICATIONS OF OPPOSED ANVIL DEVICES*

By F. DACHILLE and RUSTUM ROY
(*Pennsylvania State University, University Park, Pa., U.S.A.*)

The opposed anvil system for generating ultra-high pressures has been applied to a wide variety of crystal-chemical and mineralogical studies. An enlarged apparatus operated by a 400-ton press, capable of high-pressure studies with 'gram'-sized samples in the usual manner, has been adapted to internal heating and 'hydrothermal techniques' and also to the mapping of load distribution in wafer samples, using as indicators the changes of electrical resistance at the pressure transitions of metals. An important finding of the latter study is the pressure intensification possible in the centre of sample wafers dependent on their diameter–thickness ratios.

Introduction

In studies of solids where pressure was one of the major variables, a number of experimental systems have been devised to utilise the optimum properties of the materials of construction. The simplest and a very productive system, which is also the one reaching the maximum static pressures, is based on the principle of two opposed anvils first effectively used by Bridgman.[1] In apparatus of this type, high pressures are supported on a small area of the anvils (Fig. 1), and the sample is thin enough to be retained entirely by friction at the edges, thus dispensing with any type of containing cylinder. By appropriate stressing of an inner anvil by shrink fit and tapered supports, pressure two or three times greater than the compressive strength of the anvil materials could be attained. The characteristic distinction of these anvils is the absence of any containing 'cylinder'. With such apparatus, Bridgman claimed to have reached pressures near 200 kb with a 'single stage' and 425 kb with a 'two stage' device. He had worked at temperatures usually close to room temperature with a few runs near 300°. Further impetus was given to studies at high temperatures by the interest of petrologists (Griggs & Kennedy[2]) in work on synthesis and phase equilibria in mineralogical systems, following the reports of Coes[3] on the synthesis of several high-pressure phases in piston-cylinder apparatus. Since then the orderly development of this type of apparatus, both to extend the temperature and pressure limits, as well as to calibrate the pressures, has extended the usefulness of opposed anvils greatly.

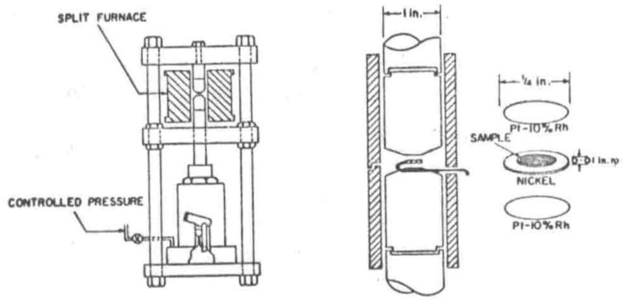


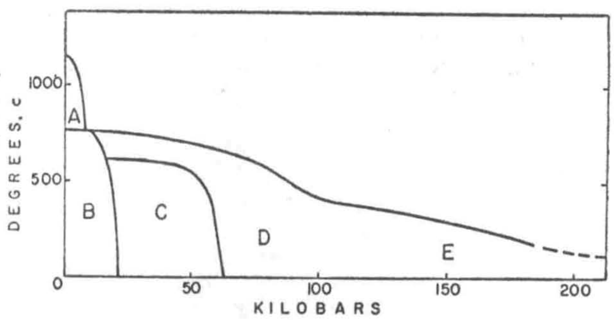
Fig. 1. *Sketch of opposed anvil apparatus with enlarged views of anvil and sample assemblies*

The proportions are for a frame with three 1 in. dia. tie-rods with a 20-ton hydraulic ram as the load unit. For work in the 200 kb region with ¼ in. dia. sample assemblies frames of at least 60 tons capacity are required.

In Fig. 2 is summarised the effective working range of opposed-anvil apparatus for runs of at least 3-h. duration. Greater frequency of breakage is to be expected near the upper limits shown because of critical factors such as alignment and non-uniform sample packing.

Fig. 2. *Effective combined* P–T *working range of various anvils for runs of over* 3 *h. duration*

In the various portions the following types of anvils are used: A, polycrystalline alumina; B, Rene' 41; C, 66 HS or Speed Star; D, Tungsten carbides-in-Rene'; and E, Tungsten carbides-in-TK tool steel.



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