

Switchable Phase Transition between Crystalline and Amorphous States of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ by Dynamic Shock Waves

A.Sivakumar^a, S.Sahaya Jude Dhas^b, Abdulrahman I. Almansour^c, Raju Suresh Kumar^c,
Natarajan Arumugam^c, S.A.Martin Britto Dhas^{a*}

Crystal Growth Details

$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ powder (Sigma-Aldrich Company) was used to grow copper sulfate crystals by slow evaporation method and distilled water was used as the solvent. The mixture of distilled water and copper sulfate pentahydrate salt was mixed up well using a magnetic stirrer to get saturated solution. Thereafter, the obtained saturated solution was filtered using a filter paper and allowed for slow evaporation at ambient condition. A good quality and defect free copper sulfate crystals were harvested after 25 days with the dimension of $14 \times 12 \times 2 \text{ mm}^3$. The grown control copper sulfate crystal is shown in Fig. 9(a). Two other crystals of the same dimension were subjected to shock wave recovery experiment. Shock wave loaded crystals do not undergo any visible changes in size, color, damages, etc., as shown in Figs. 1(a-c).

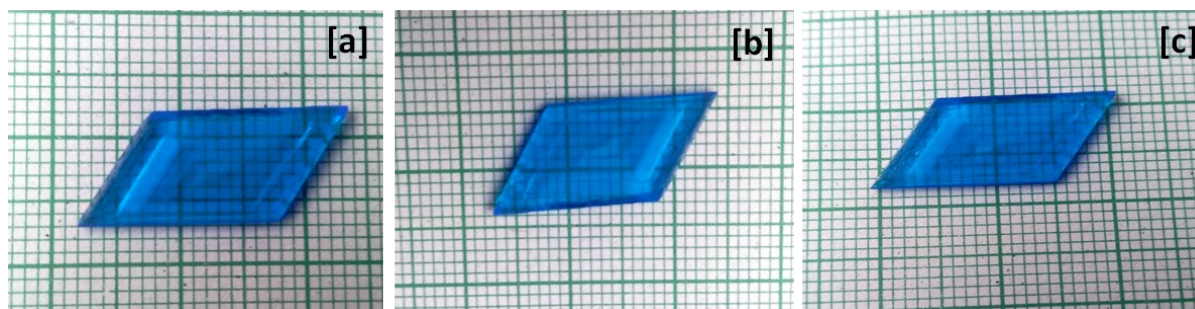


Fig.S1 Photograph of the control and shocked crystals (a) control, (b) 1st shocked (c) 2nd shocked

Shock wave loading technique

The required shock waves are generated by an in-house semiautomatic Reddy Tube which is capable of producing shock waves up to Mach number 4.5. It has three sections such as driver, driven and diaphragm sections. The driver and driven sections are made of seamless steel tubes of length 48 cm and 33 cm, respectively and both have the same inner diameter of 1.5 cm. Atmospheric air is used as the working substance for the required shock wave generation which is supplied by a tabletop mini 1 HP air compressor that has the capacity of 8 bars pressure storage. The diaphragm section separates the driver section and the driven section. Carbonless

paper diaphragms are fed into the diaphragm section with the help of a motor. While the atmospheric air is being compressed into the driver section, at the critical pressure, the diaphragm is ruptured such that the shock wave is generated and moves along the driven section. The schematic diagram of the shock tube is presented in Fig.2.

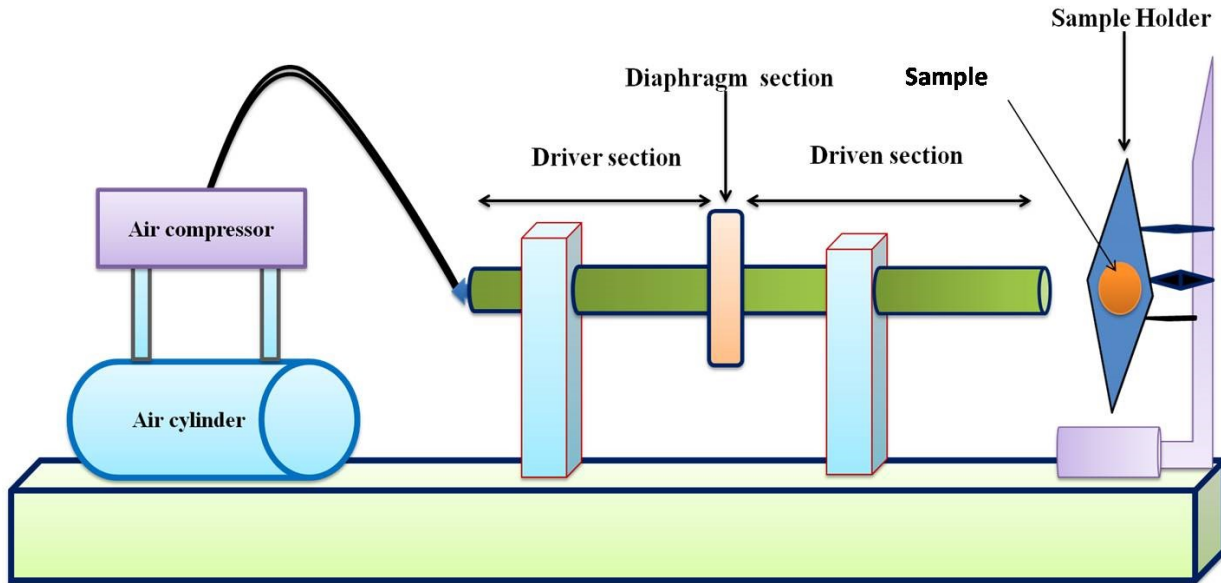


Fig.S2 Schematic diagram of the shock wave loading setup

One end of the driver section is connected to the diaphragm section which has two pneumatic cylinders and the other end is connected to the compressor. The pressurized air is also utilized for the operation of pneumatic cylinders. Using the pressure controller of the driver section, we can control the input pressure range of the driver section.

Operation of the shock tube

Pressure of the air in the driver section is gradually increased by the air compressor until the diaphragm ruptures which leads to the generation of shock wave traveling along the axis of the driven section. The required numbers of test samples are to be placed one by one in the sample holder which is typically placed 1cm away from the open end of the driven section. Subsequently, required numbers of shock pulses are loaded on the respective test sample with an interval of 5 sec between each shock pulse. 50 number of shock pulse means that the sample is exposed for 50 times by shock wave of a particular Mach number. After the completion of the

shock wave loading experiment, the control and shock wave loaded samples are sent for analytical studies.