# RESEARCH ATTRACTIVENESS OF $SiO_2$ - TARGETS FOR PLASMA PHYSICS STUDIES

**Efremov V.P.[1], Solovyev A.M.[2]**
**[1]JIHT RAS, Moscow, Russia, [2]MIPT, Dolgoprudniy, Russia**

Silica is one of the most intensive studied materials due to its great importance in Earth science and materials science.

Liquid silica is one of the major components of geophysically relevant melts (magmas). Partial melts are believed to exist in Earth at depths as great as the core mantle boundary (136 GPa, 2890 km depth). Knowledge of the physical properties of liquid silica under extreme pressure and temperature conditions of the deep interior is essential to modeling the thermal, chemical, and dynamical states of the early Earth.

Silica in its various crystalline and amorphous forms finds several industrial applications including being a raw material for glasses, ceramics, production of silicon, etc. Quartz oscillators and optical fibers are used extensively in long distance telecommunications and industry.

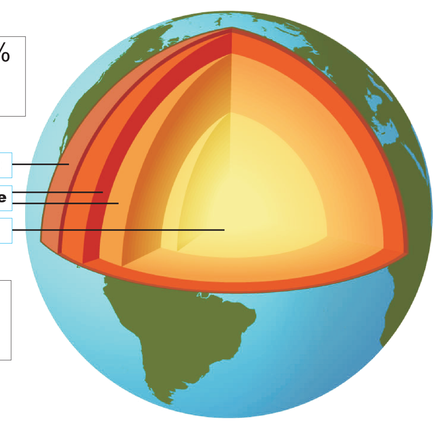
Liquid SiO2 is also of interest for more fundamental reasons, as it is a prototype of network-forming liquid.

Silica is an working space for developing powerful optical fiber lasers.

Silica aerogel is widely used for inertial fusion targets.

For description of this processes information for wide P - T area of phase diagram is needed.

$SiO_2$ - 59,71 % (in crust) in mass percent




$SiO_2$ - 46 % (in mantle) in mass percent

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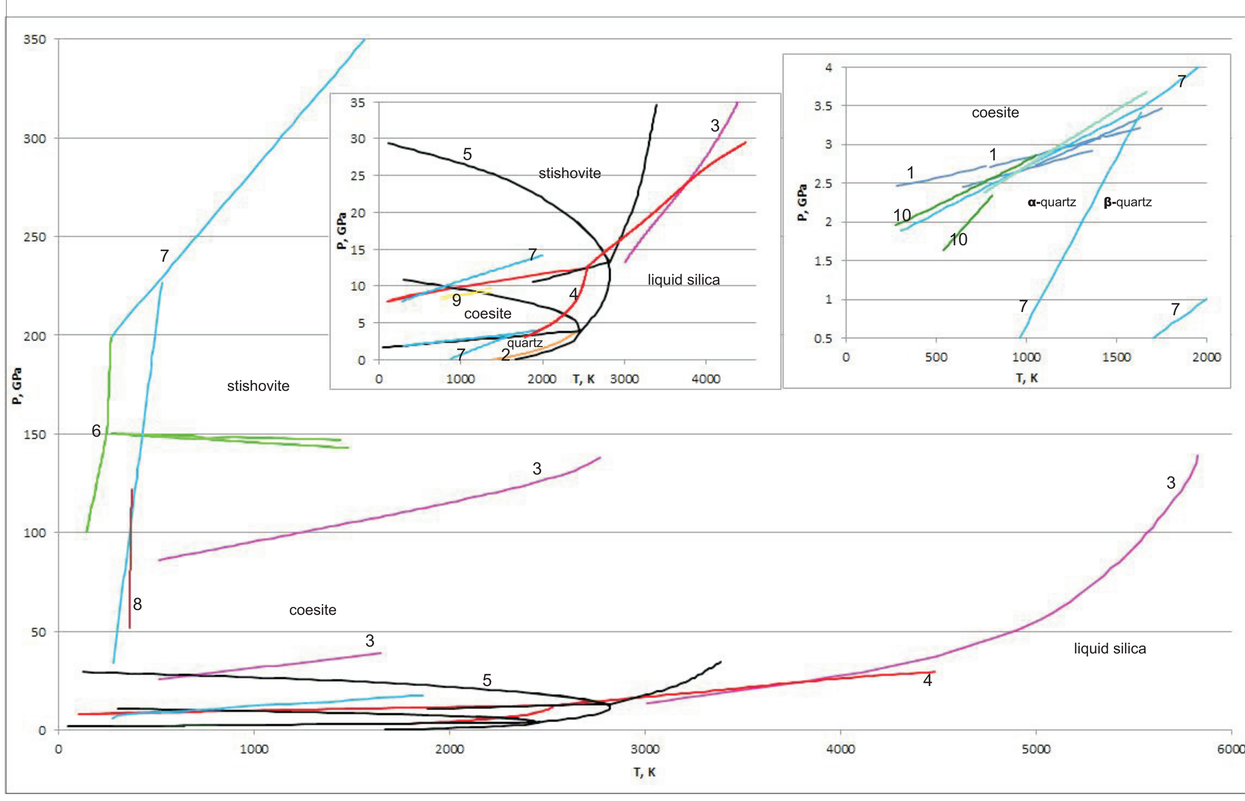
## Phase Diagrams of SiO2

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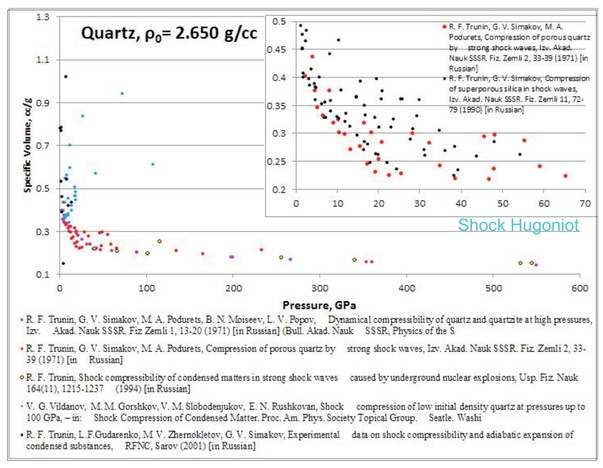


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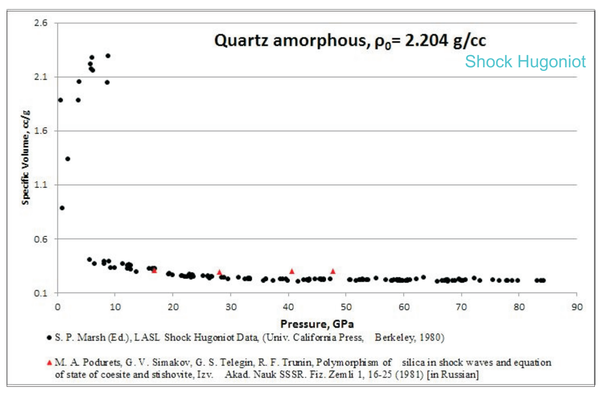


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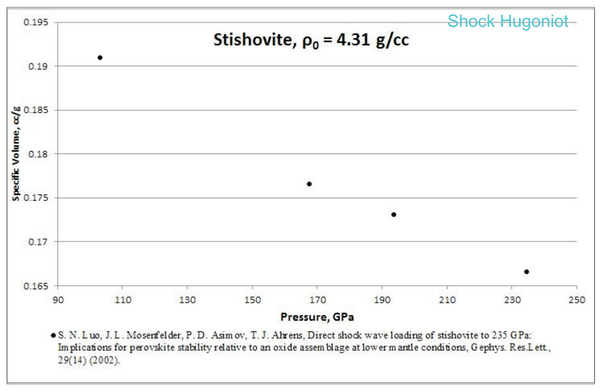


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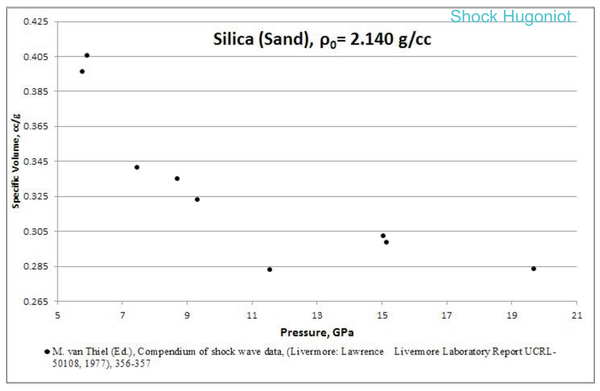


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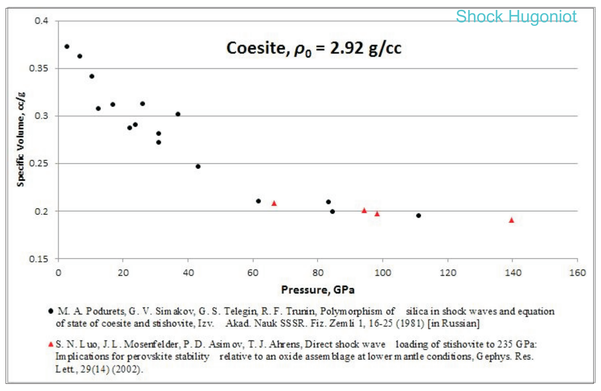


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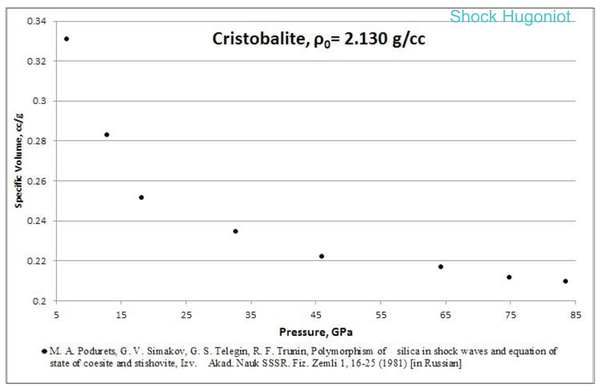


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## Conclusions

- **We found unexplained by measurement errors difference in the melting curve of stichovite in the temperature range 2900 K – 4400 K. [1,2,3]**
- **We found a different curve slope of the phase transition coesite – stishovite. [1,2,5]**
- **We found differences in the melting curve of quartz. (E.g. it reaches a value 2.8 in the range 1600 K - 2300 K). [1,4]**
- **Also it should be noted that there are sparse data at high pressure area as opposed to the area T = 0 – 4000 K, P = 0 – 35 Gpa.**
- **We plan to make revision of phase diagram data in a wide range and investigate unexplored area by experimental ad theoretical methods.**

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**[4] E. Bourova and P. Richet, Geophys. Res. Lett., 25 [13] 2333-2336 (1998).**
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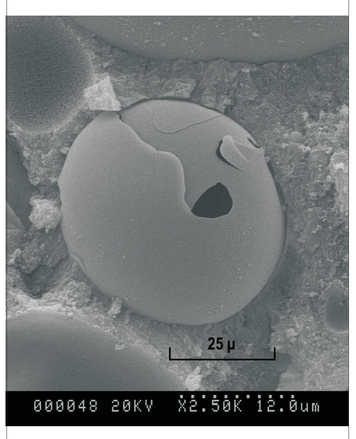
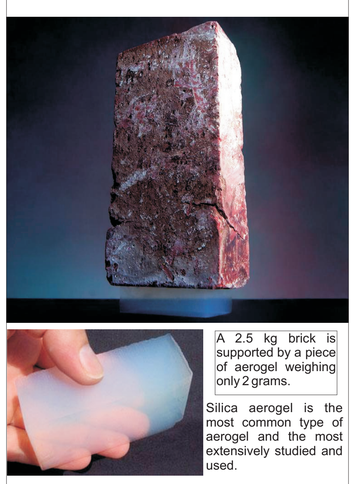
## Applications of $SiO_2$ for high energy physics

### Glass Microspheres




Glass microspheres are microscopic spheres of glass manufactured for a wide variety of uses in research, medicine, consumer goods and various industries. Glass microspheres are usually between 1 to 1000 micrometers in diameter, although the sizes can range from 100 nanometers to 5 millimeters in diameter. Hollow glass microspheres, sometimes termed microballoons, or glass bubbles have diameters ranging from 10 to 300

### Silica Aerogel

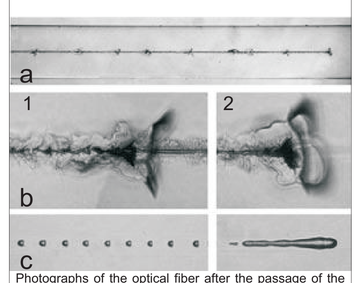


A 2.5 kg brick is supported by a piece of aerogel weighing only 2 grams.

Silica aerogel is the most common type of aerogel and the most extensively studied and used.

see for details: O. N. Rosmej, A. Blazevic, S. Korostiy, R. Bock, D. H. H. Hoffmann, S. A. Pikuz, Jr., V. P. Efremov, V. E. Fortov, A. Fertman, T. Mutin, T. A. Pikuz, A. Ya. Faenov "Charge state and stopping dynamics of fast heavy ions in dense matter", PHYSICAL REVIEW A 72, 052901 (2005)

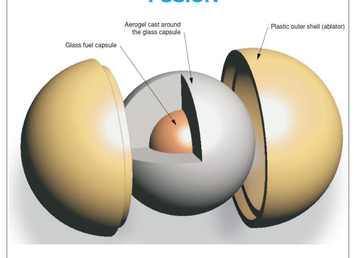
### Fiber Fuse Effect

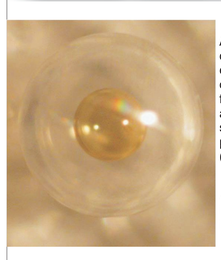



Photographs of the optical fiber after the passage of the optical-discharge wave through its core. The laser radiation in all the frames propagates from the right to left. (a) Damage to the core after the passage of the fast optical discharge wave; the optical fiber diameter observed in the photograph is equal to 600 µ m. (b) Damage to the core of the optical fiber in an increased scale (the frame height corresponds to 100 µ m: (1) the region of the intermediate stop of the optical discharge between the laser pulses and (2) the point of the final stop of the optical discharge. (c) Damage to the same core after the passage of the slow optical dischargewave (1) at 1 mm from the stop point and (2) at the stop point after interrupting the laser beam with a mechanical gate; the scale is the same as in (b).

E. M. Dianov, V. E. Fortov, I. A. Bufetov, V. P. Efremov, A. A. Frolov, M. Ya. Shchelev, V. I. Lozovoi "Detonation-like mode of the destruction of optical fibers under intense laser radiation." Journal of Experimental and Theoretical Physics Letters, 2006, 83:2, 75–78

### INERTIAL CONFINEMENT FUSION

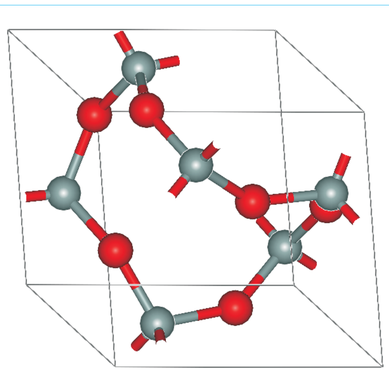


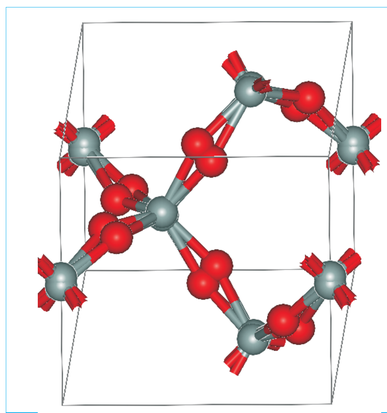
top picture:
A double-shell target designed for fusion experiments consists of an inner capsule of fuel supported in aerogel and surrounded by a plastic outer shell (ablator).

left picture:
A double-shell target is just 0.5 millimeter in diameter.

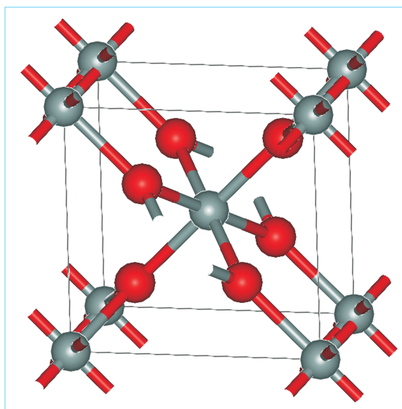
Lawrence Livermore National Laboratory, S&TR September 2006



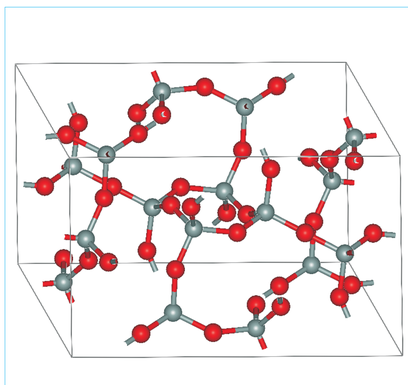
**α-quartz (trigonal crystal) density - 2.65 g/cc**



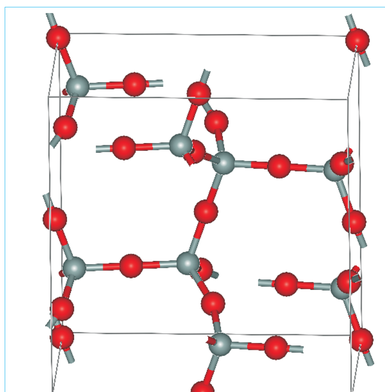
**β-quartz (hexagonal crystal) density - 2.65 g/cc**



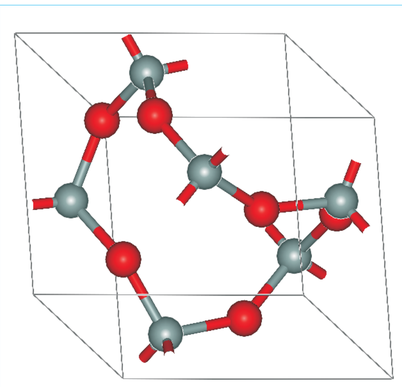
**stishovite (tetragonal crystal) density - 4.28 g/cc**



**coesite (monoclinic crystal) density - 2.93 g/cc**



**α-tridymite (rhombic crystal) density - 2.3 g/cc**



**β-tridymite (hexagonal crystal) density - 2.3 g/cc**

**The 4th EMMI workshop on Plasma Physics with Intense Heavy Ion and Laser Beams.**