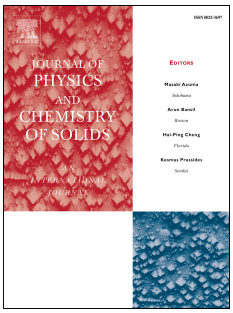
Accepted Manuscript



Thermal behavior of compressed materials

Stepan S. Batsanov

PII: S0022-3697(18)30263-4

DOI: 10.1016/j.jpcs.2018.06.002

Reference: PCS 8616

To appear in: *Journal of Physics and Chemistry of Solids*

Received Date: 1 February 2018

Revised Date: 1 June 2018

Accepted Date: 2 June 2018

Please cite this article as: S.S. Batsanov, Thermal behavior of compressed materials, *Journal of Physics and Chemistry of Solids* (2018), doi: 10.1016/j.jpcs.2018.06.002.

Thermal behavior of compressed materials

Stepan S. Batsanov

National Research Institute for Physical-Technical Measurements, Moscow Region 141570, Russia

A B S T R A C T

Differences in volumes of materials compressed by the static (cold) and shock-wave (adiabatic) methods are caused by the enhanced temperatures in the last case. Using experimental data for compressed materials we determined coefficients of thermal expansion under pressures for 49 elements, most of which demonstrate the positive sign, but Rb, Sr, Ga, Sb, C_{gra} and I under 1 GPa; Ti, V, Re, I, Fe, Ir and Th under 10 GPa show negative coefficients of thermal expansion. In the case of Th, La, Ga, Zr, Sn, Sb and Ir a sign of the volume change depends on the pressure values.

Keywords: Metals; Compression; Thermal expansion

1. Introduction

Information on thermo-physical properties of materials is of technological importance. Thus, materials with zero thermal expansion are useful for forming space devices, bridges, and piping systems, while materials with very large thermal expansion may function as actuators, but those which contract upon heating may act as thermal fasteners [1]. Thermal behavior of substances has also of fundamental interest for understanding mechanisms of their expansion or contraction upon heating [2].

As well known, most solids expand upon heating and may be characterized by usual coefficients of thermal expansion (CTE), but there are materials which show the inverse effect, i.e. contract upon heating, and hence have the negative thermal expansion (NTE). If the former effect is normal phenomenon, then the NTE is unusual one, which however was many times experimentally observed. So, in 1897 Guillaume reported [3] on NTE in $Fe_{65}Ni_{35}$. Later, NTE behavior was observed at very low or at enhanced temperatures (often at the phase transitions) in such elements or binary compounds as C (diamond), Si, Ge, GaAs, GaSb, InAs, InSb [4]; AgI, LnF_3, PbO, TiO_2, ZrO_2, GeO_2, Ln_2O_3, Sb_2O_3, Bi_2O_3, HgS, MnS, Ln_2S_3 [5]; GeSSe, GeSTe, GeSeTe [6]; water and h-ice [7]; ReO_3 [8,9]; ScF_3 [10]. It is known also many complex compounds with NTE such as Ag_2SO_4, $BaCO_3$ [5], $Zr(WO_4)_2$ [11], $Li_2B_4O_7$ [12], ZrV_2O_7, $Sc_2(MoO_4)_3$, $Sc_2(WO_4)_3$, zeolites, metal-organics, polymers and fibres (see a review [13]). Colossal NTE was established in the $Pb(Ti,V)O_3$ perovskites by Azuma group [14]. All these substances

E-mail address: batsanov@mail.ru