the unit cell), T-192 (tetragonal, with 190-192 atoms per unit cell), and γ-boron (high pressure phase, orthorhombic, with 28 atoms per unit cell). The new phase turned out to be a key to understanding the phase diagram of boron—the only element for which the phase diagram was unknown since its discovery 200 years ago.

Here, we report the synthesis of γ- and T-192 boron from β-boron at pressures up to 18 GPa and temperatures up to 2200 °C using a multi anvil apparatus combined with x-ray diffraction (XRD) and Raman spectra. Based on the XRD and Raman results, we give the phase boundary of β-, γ-, and T-192 boron. Fig.1 shows the phase relations between β-boron (open), γ-boron (solid) and T phase (inverse triangles) based on the results of the multi anvil quenched experiments. The semi-solid circles represent β-boron and γ-boron in coexistence. The line is a phase boundary between β-boron and γ-boron, and the inset show the theoretical phase boundary from Oganov et al.[1] and the tentative phase boundary from Zarechnaya et al.[2]. Additionally, the two open inverse triangle represent P-T conditions of T-192 phase from Oganov et al.[1] and Ma et al.[3] respectively. Combined with the previous results [1], [2] and our study, γ-boron phase becomes stable under certain pressures (above ~8.5 GPa), and β-boron can transform into γ-boron above ~8.5 GPa and using heating to overcome kinetic barriers, and the kinetic barriers decrease with increasing pressure. However, at higher temperatures, β-boron and T-192 phase are more stable than γ-boron, thus γ-boron transforms back to β-boron (~9 GPa) or continues to transform into T-192 phase (above ~10 GPa) with increasing temperature depend on undergoing high pressure.

Recent discovery of iron-based perovskites $\text{ACu}_2\text{Fe}_2\text{O}_5$ ($A=\text{Ca}$ and La) has been attracting much interest due to the fascinating and unexpected properties. A charge disproportionation (CD) of Fe$^{3+}$ into Fe$^{2+}$ and Fe$^{4+}$ occurs in $\text{CaCu}_2\text{Fe}_2\text{O}_5$ (CCFO) [1], whereas an intersite charge transfer (CT) between Cu and Fe results in a large volume change in $\text{LaCu}_2\text{Fe}_2\text{O}_5$ [2]. The different electronic phases resulted from CD/CT imply that further anomalous properties can be achieved in this system.

A novel iron-based perovskite $\text{SrCu}_2\text{Fe}_2\text{O}_5$ (SCFO) was successfully synthesized using high-pressure of 15 GPa. The structural and physical properties of SCFO were in contrast to those of the known $\text{ACu}_2\text{Fe}_2\text{O}_5$ ($A=\text{Ca}$ and La) perovskites. SCFO demonstrated a large negative thermal expansion (NTE) with a linear expansion coefficient (ca. $-2\times10^{-5}$ K$^{-1}$ at maximum) in a temperature range of 170–270 K. The Rietveld refinement based on the synchrotron X-ray powder diffraction data revealed that the NTE was attributed to a continuous inter-site CT between Cu and Fe. Mössbauer spectroscopy exhibited that SCFO resulted in a charge disproportionated state below ~200 K. The relative abundance of Fe$^{2+}$:Fe$^{4+}=4:1$, which is different from the ratio of 1:1 for CCFO, implies the electron doping into Fe through inter-site charge transfer.


**Keywords: novel perovskite, negative thermal expansion, high-pressure synthesis**

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Electron and magnetic properties in high temperatures magnetic semiconductors at high pressure up to 7 GPa

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In high-temperature ferromagnetic semiconductors $\text{Cd}_x\text{MnGeAs}$ ($x=0.36$) and $\text{Cd}_x\text{MnGeP}$ ($x=0.225$) there is carried out a complex experiment of electric and magnetic properties. The baric dependences of the specific resistance $\rho$, Hall coefficient $R_h$ and relative magnetic susceptibility $\chi/\gamma$ are measured. The $\rho(P)$ and $R(P)$ are measured in high-pressure device of “Toroid” type [1], [2] when pressure rises and falls up to 7 GPa. The magnetic susceptibility is estimated by a method described in the work [3]. Structural phase transitions are found in baric dependences of $\rho(P)$ and $R(P)$ in both compounds at increase and decrease in pressure. A position of phase transitions shifts towards the high pressures when a percentage of Mn increases. All phase transitions are reversible in $\text{Cd}_x\text{MnGeAs}$, in $\text{Cd}_x\text{MnGeP}$, samples with $x \leq 0.135$ the phase transition is accompanied by partial decomposition of a substance, what confirms the X-ray diffraction study before and after pressure applying on dependences $(\chi/\gamma)/P$. In all samples of both compounds there are observed the magnetic phase transitions which shift towards high pressures with increase in percentage of Mn. When pressure decreases the hysteresis emerges. A magnetic phase transition is not revealed in base samples of CdGeAs and CdGeP. We interpret the observed phase transitions as non-magnetic phase transition [4]. The temperature dependences of normal and abnormal Hall coefficients are calculated from magnetic-field dependences of Hall resistance for $\text{Cd}_x\text{MnGeAs}$, ($x=0.36$) by the method of interactive graphical plotting.

**Keywords: novel perovskite, negative thermal expansion, high-pressure synthesis**

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Structural anomaly in a novel iron-based perovskite

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