Chemical interaction and phase relations in the B–P system as well as melting of BP have been investigated in situ at pressures up to 20 GPa and temperatures up to 2800 K using energy-dispersive X-ray diffraction with synchrotron radiation and multianvil high-pressure apparatuses MAX80 (beamline F2.1) and MAX200x (beamline W2). Crystal structure of the recovered samples has been studied by powder X-ray diffraction with synchrotron radiation (beamlines B2 and BW5). No chemical interaction is observed at temperatures below phosphorus melting. BP is the only thermodynamically stable boron phosphide at high pressures, while $\text{B}_1\text{P}_2$ forms occasionally as a metastable phase at the first stage of the chemical interaction. At high pressures BP melts congruently in contrast to ambient pressure. The melting curve has negative pressure slope and is located much lower than the theoretically predicted one [1]. The thermoelastic equation of state of BP has been established up to 7 GPa and 2500 K (Figure). The 300-K bulk modulus was found to be 171 GPa.

Finally, the thermodynamic aspect of the phase formation in the B–P system at high pressures and high temperatures has been clarified. The data obtained are expected to help to optimize conditions of high-pressure growth of BP single crystals and develop the principles of producing new advanced B–P materials.

References