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High-pressure ^{13}C-diamond-forming reaction of decomposition of $Na_2^{13}CO_3$ melt at 20 - 60 GPa

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The available analytical data on mineralogy of syngenetic inclusions in superdeep diamonds from the Juina area (Brazil) provided important information on the general chemical composition of the parental medium for the host diamonds and included minerals. Carbonate micro- and nano-inclusions of calcite $CaCO_3$, dolomite $CaMgCO_3$, nyerereite $Na_2Ca(CO_3)_2$, and nahcolite $NaHCO_3$ were identified among the heterogeneous suite of primary inclusions. Chemical and PT conditions of syngenetic formation of the superdeep diamonds and mineral inclusions therein may be discovered using high-pressure experiments focused onto study of chemical stability of carbonate components, involved into the diamond-forming processes, and their melts.

We studied high-pressure high-temperature behavior of sodium carbonate Na_2CO_3 in laser-heated diamond anvil cells. A starting material was a pure $Na_2^{13}CO_3$ mixed with platinum powder in ratio approximately 20:1. The mixture was loaded into high-pressure chamber between two layers of pure $Na_2^{13}CO_3$. Platinum powder acts as an absorber of the NIR laser light. Re gaskets of 200 μm in thickness were pre-indented to about 30 μm in thickness, then holes of about 130 μm in diameter were drilled in the gasket centres. The samples were compressed between diamond anvils with 250-μm culets at room temperature to pressures between 20 and 60 GPa. Ruby balls placed inside the pressure chamber were used as the pressure calibrants. After quenching, the samples were studied by Raman spectroscopy using Dilor XY Raman spectrometer and Ar^+ ion laser (514.5 nm, Coherent Innova 300). Using ^{13}C-carbonate we can unambiguously distinguish carbon phases produced in course of experiments as results of decomposition of carbonate and avoid a possible contamination from ^{12}C-diamond anvils.

High-pressure melting of sodium carbonate is congruent within the 20 – 60 GPa pressure interval. Formation of ^{13}C-diamond was detected after heating sodium carbonate melt at 34.5 GPa and higher temperature 2400 K. In the sample heated at 33 GPa and 2600 K, we found a broad G-band at 1545 cm^{-1} (^{12}C -graphite originated, probably, from diamond anvils) and a sharp band at 1315 cm^{-1} (newly formed ^{13}C-diamond). The bands correspond to mixture of graphite and diamond with isotopic ^{13}C:^{12}C ratio about 1:1. The ^{13}C -diamond was synthesized, evidently, due to the reaction of decomposition of sodium carbonate melt with formation of dense fluid phase CO_2 decomposed with liberation of elemental carbon. Further studies of $CaCO_3$ are in progress in order to determine a melting curve and decomposition boundary of sodium carbonate melt, as well as PT-parameters of its phase stability region.

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