Carbon Condensation during Detonation of High Explosives of Various Diameters.

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In recent years, small-angle X-ray scattering (SAXS) of synchrotron radiation (SR) has been widely used to study carbon condensation during an explosion [1-3]. SAXS patterns depend on nanoscale density fluctuations in the detonation process. During the detonation of oxygen-deficient high explosives (HEs), the occurrence of these fluctuations is related to the formation of condensed carbon in different phases.

Earlier [1] we obtained the growth dynamics of condensed carbon nanoparticles during the detonation of a wide range of oxygen-deficient high explosives 20 mm in diameter. For TNT and TNT/RDX charges, the time of carbon nanoparticle growth is about 1 μs, and for benzotrifuroxan charges, it is about 2.5 μs. The dynamics of SAXS patterns during the detonation of hexanitrostilbene charges about 6 mm in diameter was obtained in [2, 3] at the Advanced Photon Source. The change in the shape of the SAXS patterns ceases to change in 300 ns after the passage of the detonation front, and in 400 ns up to several microseconds, the shape of the pattern is constant. The time of the change in the SAXS pattern can vary over a wide range, depending on the HE and perhaps the charge diameter.

In this work, the carbon condensation process depending on the diameter of the HE charge was investigated using TNT and TNT/RDX charges 20, 30, and 40 mm in diameter. Experiments were carries out at a new experimental station where the VEPP-4M accelerator complex (BINP SB RAS) was used as a source of SR. SAXS patterns were recorded with a modified DIMEX-3 detector.

Condensed carbon particles in the detonation products have a complex structure. Two methods were used to determine the size of condensed carbon structures from SAXS patterns. The Guinier method was used to determine the dynamics of the average size of scattering nanoparticles. In the second method, SAXS patterns were approximated by a set of scattering intensities from homogeneous spherical particles of different diameters. Both methods give consistent results.

Scattering centers with an average size of about 4-6 nm were formed in the first 600 ns behind the detonation front. After that, their growth for several microseconds was observed.

The time of nanoparticle growth behind the chemical reaction zone increased to 4-8 μs when the charge diameter was changed from 20 to 40 mm.

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