Experimental Liquid Carbon Resistivity

V.N. Korobenko, A.D. Rakhel, and A.I. Savvatimski
High Energy Density Research Centre
Moscow, Russia

M. Boivineau, R. Cheret, and Th. Thevenin
Commissariat a l'Energie Atomique
Centre de Valduc
F-21120 Is-sur-Tille, France

Two main kinds of pyrolytical graphite specimens were under investigation during fast (several μs) heating by pulse of electrical current. The first is a cylindrical form, like a needle, with non-perfected structure, the second - square form needles, highly oriented graphite. The specimens were placed in sapphire capillary tubes, which restricted the volume around the specimens. The derivative of the graphite resistance in the solid state under heating was changed at the moment of filling the inner cavity of sapphire tubes. This effect was not observed for highly oriented graphite. The resistivity of the graphite in the restricted volume (under high pulse pressure) does not rise above 500 μΩ cm, up to the imparted energy W = 55 kJ/g (evaluation of T gives 11000 K). After the melting ($W \geq 20$ kJ/g) of highly oriented graphite, the resistivity in liquid (as we supposed) state, under high pressure, sharply diminishes from ~ 620 μΩ cm to ~500 μΩ cm.

Graphite expansion from solid state through melting and further in liquid state — is a linear function of imparted energy (7 kJ/g – 25 kJ/g). During melting, as we supposed from 10 kJ/g to 20 kJ/g, the rise of the volume is 30%. Resistivity of liquid graphite (above W= 20 kJ/g) depends on the value of its specific volume. The smaller the specific volume is (under high pressure) — the smaller the value of resistivity. The value of the resistivity in the liquid state, in our fast experiment, is near 500 μΩ cm. Graphite with not high density ($\gamma \sim 1.6$-1.9 g/cm^3) has resistivity of large value for initial solid state and under heating there is a slight rise, up to the melting. At the start of melting the resistivity begins diminishing. Graphite with high density ($\gamma \sim 2$ - 2.26 g/cm^3) has initial resistivity of small value for solid state. Under heating there is a strong rise not only to the beginning of the melting, but up to the finishing of the melting. Only in liquid state the resistivity begins diminishing, if the high pressure is used.

For additional series of the experiments we used the slower velocity of heating for the same specimens. The details will be published in the whole paper.