3 - 19 Prospects of Warm Dense Matter generated by Intense Heavy Ion Beam at HIAF Facility*

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Warm dense matter, an intermediate state of matter between a solid and an ideal plasma, has a density as a solid, a temperature of a few eV, and a pressure of some Mbar, which exists in the cores of large planets and the path to inertial confinement fusion. However, in this state, because of the strongly coupled particles, the assumptions of both condensed matter theory and ideal-plasma theory break down, the quantum mechanics and other effects become of the importance as well.

Intense heavy ion beam is a unique tool to generate the warm dense matter state except for the high power laser. It can produce a warm dense matter with large size, any material, homogeneous heating condition, good reproduction and high repetition rate. High Intense heavy ion Accelerator Facility (HIAF), officially approved by government in 2015, provides the new opportunity for the research of warm dense matter in laboratory.

A simulation work has been done with the collaboration of Dr. Naeem (GSI). A $^{238}U^{34+}$ ions beam with energy of hundreds of MeV/u, intensity of $\sim 10^{11}$ ppp, a bunch length of 100∼150 ns and a beam spot of ∼1 mm, is accelerated by BRing at HIAF and transported to heat a solid cylindrical lead target which has a length of 5 mm, a radius of 4 mm. The calculated results that the deposited energy vs. radius and temperature, pressure and densityvs. radius are shown, respectively(Fig. 1).

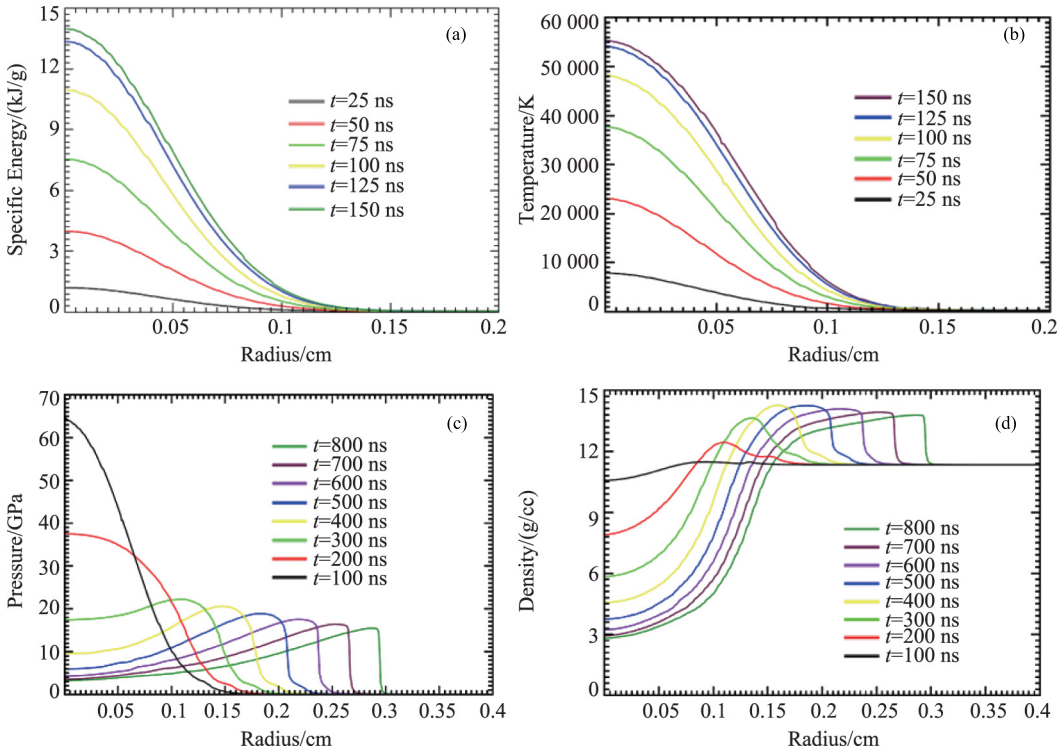

Fig. 1 (color online) The calculated results that the deposited energy vs. radius (a), and temperature (b), pressure (c) and density (d) vs. radius are shown, respectively.

It is seen from the result that a maximum deposited energy of 14 kJ/g, temperature of 55 000 K, pressure of about 60 GPa and density of 10 g/cm^3 state of lead target can be achieved by the intense uranium ions beam heating at BRing of HIAF.

All the results show that the ion beam that will be available at HIAF facility is power enough to generate warm dense matter in the laboratory. The researches including Equation-of-State at extreme condition, hydrodynamic response and instability problems in warm dense matter can be performed.

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