【Grant-in-Aid for Scientific Research(S)】

Science and Engineering (Mathematical and physical sciences)

Title of Project : Study of Creation and Freezing Mechanisms of High Energy Density Solid Stats

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Research Area : Mathematical and Physical Science, Plasma Science

Keyword : High energy density stats, High power laser, high pressure condensed matter,

【Purpose and Background of the Research】

We will realize high-energy density (HED) diamond, which is called "super diamond", by using dynamic compression techniques with high-power lasers. It is predicted theoretically that the super diamond (BC8) is denser by 2 times and much harder than normal diamond.

Using our previous results of metallic Si at ambient pressure on the earth, which has been realized by non-equilibrium high pressure compression, we will study on the freezing mechanism of the high energy density stats. Based on this understanding of the mechanism, we will study how to realize or have the super diamond in hand at the ambient pressure.

【Research Methods】

The super diamond (BC8 or SH phases) will be experimentally created under high pressures of TPa by using high power lasers providing energies of more than 100J in large laser facilities. To optimize the laser and target conditions to create the super diamond state, we use a middle size of a high power laser with a few 10J. The characteristic of transient states of the high pressured diamond will be investigated with in-situ diagnostics.

We will also study on the quenching process of the high energy density sate in high pressure conditions through in-situ measurements, sample analysis and model analysis of high energy density material such as metallic Si. The sample analysis will be made with a radiation source and TEM.

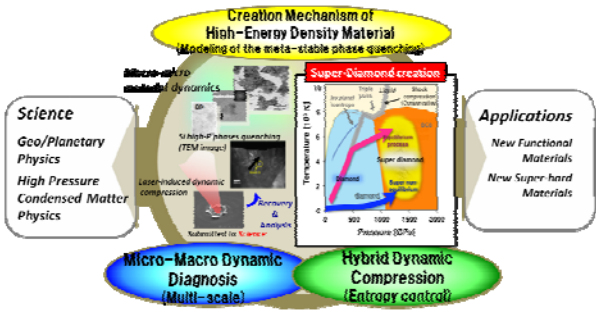

Fig. 1 approach for HED material

【Expected Research Achievements and Scientific Significance】

This project will focus on creation of high energy density solid matter with extremely high pressures of more than Tera Pascal and relatively low temperatures. Details of the phase transition under non-equilibrium high pressures will be cleared with our advanced probing and creation systems.

Under this project we will not only create the novel transient states unreachable with conventional high pressure devices alone, but also have it in hand at ambient condition. This will open a new field of material sciences including condensed matter physic, planetary physics and material process as well as the high energy density sciences.

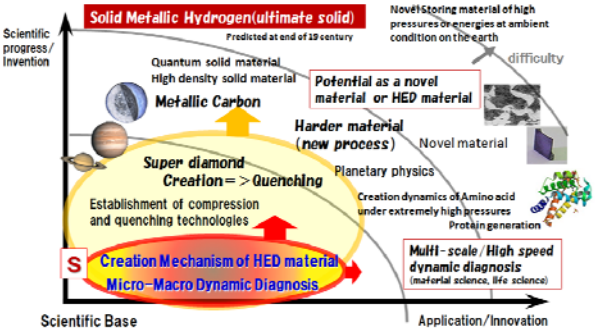

Fig. 2 Exploring of HED material and its potential for applications

【Publications Relevant to the Project】

- K. Miyanishi et al., "EOS measurements of pressure standard materials using laser-driven ramp compression technique.", J. Phys. 215, 012199-1-4 (2010).
- R. Kodama et al., "Plasma devices to guide and collimate a high density of MeV electrons" Nature 432, 1005-1008 (2004).

【Term of Project】 FY2010-2014

【Budget Allocation】 168,300 Thousand Yen

【 Homepage Address and Other Contact Information】

http://www.eie.eng.osaka-u.ac.jp/ef/