Department of Extreme States of Matter of IPCP RAS

Interaction of high energy fluxes with condensed matter
- Generation and investigation of warm dense matter under intense heavy ion beam;
- Strength and elastic-plastic properties of solids under nanosecond pulse duration;
- Thermodynamic response of condensed matter to light and heavy ion beam loading;
- Investigation of critical states of matter (melting, evaporation);
- Numerical simulation of interaction of intense ion beams with matter;
- Proton radiography for shock-wave diagnostic;

Detonation phenomena, High Explosive properties and safety
- Properties and structure of detonation waves in heterogeneous and mixture HE;
- Influence of initial density and dispersion on the structure of reaction zone of detonation wave in HE;
- Detonation properties of liquid HE: parameters, initial detonation pressure, critical diameter and front stability of detonation wave;
- Investigations of detonation properties of low sensitive and emulsion HE;
- Investigations of influence of additives on detonation properties of industry HE;

Rheological properties of condensed matter under dynamic compression and tension
- Strength and elastic-plastic properties of single crystals, metals and alloys, polymers and elastomers, ceramics, composites and liquids over wide range of strain rates (10^7–10^19 s⁻¹), dynamic pressures (up to 1 GPa) and initial temperatures (77K – 900K), spall phenomena;
- Investigation of influence of inner structure on material strength properties under shock loading;
- Cavitation processes in liquids under dynamic tension;
- Investigations of mechanisms of fracture and deformation of brittle materials under dynamic compression and tension, criteria of elastic-plastic transition;
- Mechanism of forming and propagation of failure wave in glasses and brittle single crystals under dynamic compression;

Numerical simulation of high energy density pulse processes
- Development of semi-empirical wide-range multi-phase equations of state of substances (more 150 substances);
- Numerical simulation of hypervelocity impacts of Cosmic bodies (astrophysics phenomena and experiments “Vega”, “Deep Impact”, “LCROSS”, etc.) and supersonic interaction of solids;
- Numerical simulation of interactions of intensive heavy and light ion beams with condensed matter;
- Numerical simulation of nuclear, chemical and explosive safety of civil and industry objects;
- Development of open Shock Wave DataBase (http://www.ficp.ac.ru/rusbank), including thermodynamic properties of substances in shock and isentropic release waves (more 15000 points for ~500 substances);

Physics of nonideal plasma and conversation of chemical energy of condensed HE in electromagnetic energy
- Development of HE generators of strongly coupled plasma in gases;
- Investigations of reflectivity, spectral composition and temperature of non-ideal plasma;
- Investigation of electrical conductivity and electron density in shock-compressed plasma of noble gases;
- Conversation of HE chemical energy to electromagnetic energy: development of explosive-magnetic generators, high explosive lightning simulation, conversation of HE energy to microwave radiation;
- Theory and modeling of thermophysics of strongly coupled plasmas. Thermodynamics and equations of state of matter of the Sun, stars and giant planets;

Thermophysical, electrical, optical properties of matter under extreme conditions
- Trancritical states of metals and oxides;
- Investigation of transport and thermodynamics properties of Hydrogen and Helium under quasi-isentropic compression;
- Electrical conductivity of metals and dielectrics in transition region “metal – dielectric - metal” under dynamic compression at Megabar pressure range;
- Theoretical and experimental study of transport properties at structural and electronic transitions in metals and fullerenes;

Phase transitions and dynamic synthesis of metastable substances and superhard materials
- Investigation of kinetics and mechanism of polymorphic transition “graphite – diamond” under dynamic compression;
- Influence of inner structure, initial temperature and intensity of shock loading on kinetics and parameters of phase transitions of polycrystalline metals and alloys;
- Shock wave synthesis of superhard materials: Detonation diamond, BN, BNC, Si₃N₄, C₃N₄;