Research Infrastructure of RRC "Kurchatov Institute" for works in Nanotechnology and Materials Sience Area

Ya. Shtrombakh

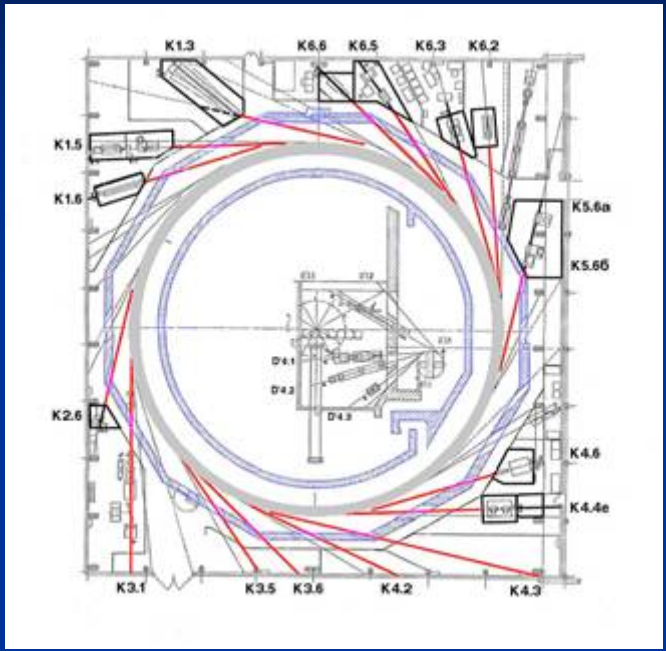
The main directions of investigation

- Creation of functional nanoelements for various purpose including for memory, sensor controls, keys, transistors etc.
- Creation of nanomaterials for various purpose, including: fullerenes, nanotubes, nuclear power materials etc.
- Creation of Micro Electromechanical (MEMS) and Nano Electromechanical (NEMS) Systems.
- Works in a scope of nanotechnology for needs of medicine and biology.
- Creation of a new manufacturing techniques for functional nanoelements and nanodevices production.
- Creation of a new manufacturing techniques for nanomaterials production.

Kurchatov Synchrotron Radiation Source

The Kurchatov Synchrotron Radiation (SR) Source is the first dedicated SR facility in Russia for the production and use of synchrotron radiation. The combination of specific properties of synchrotron radiation like high flux, collimation and polarization, temporal structure and a wide wavelength range from infrared to the hard X-rays makes the source a powerful tool for the research in physics, chemistry, biology, materials science and micro and nanotechnology.

Kurchatov Synchrotron Radiation Source



Linear accelerator (injector)

Large storage ring (X-rays)

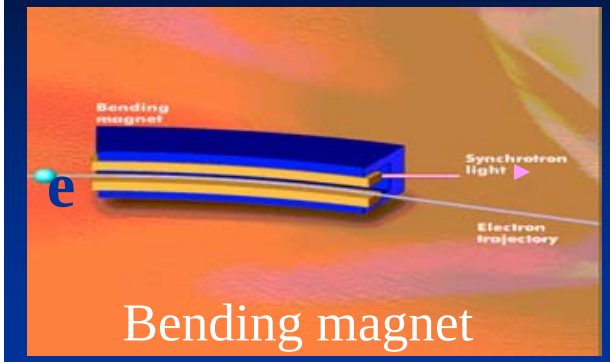
Small storage ring (booster, VUV)

Control room

«Siberia-2»

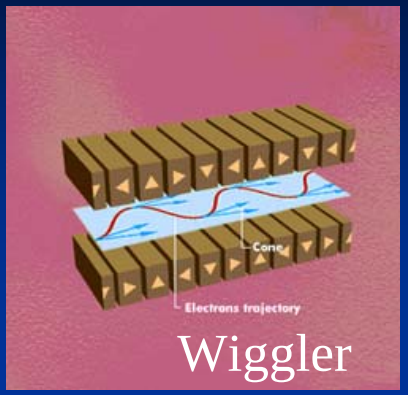
Large storage ring «Siberia-2» is a source of X-ray radiation

Synchrotron radiation: generation and properties

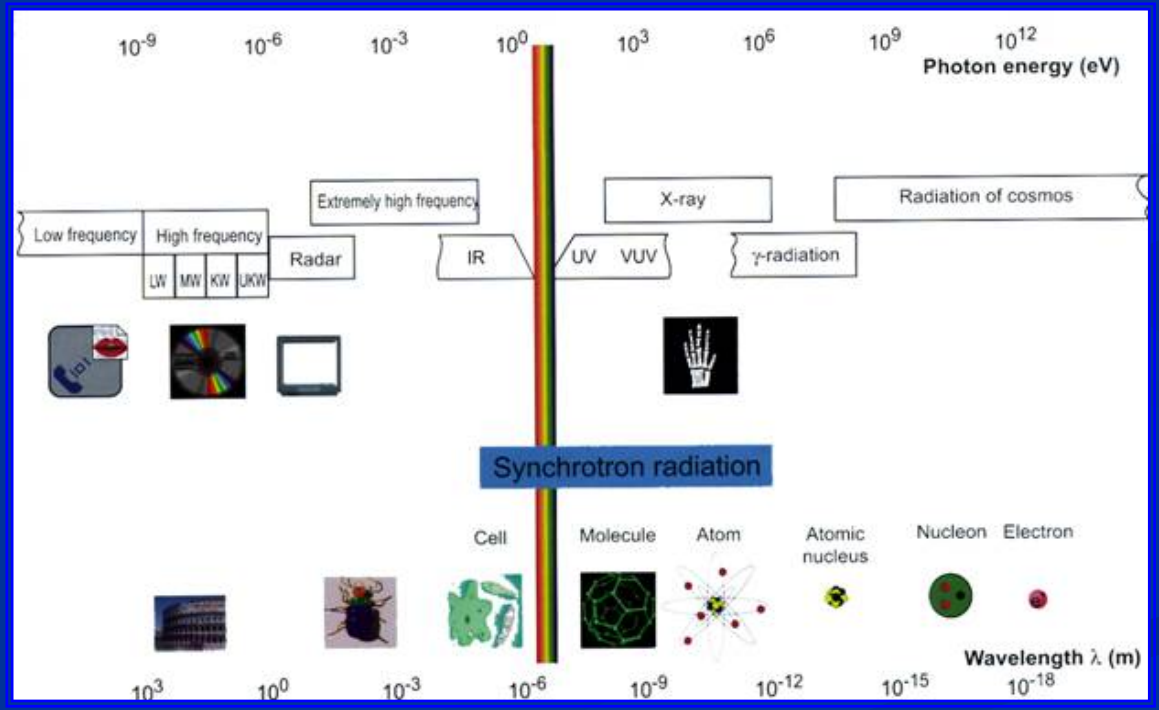


Bending magnet

- Wide spectral range
- High brilliance
- Polarization
- Time structure
- Natural collimation
- Ultra high vacuum



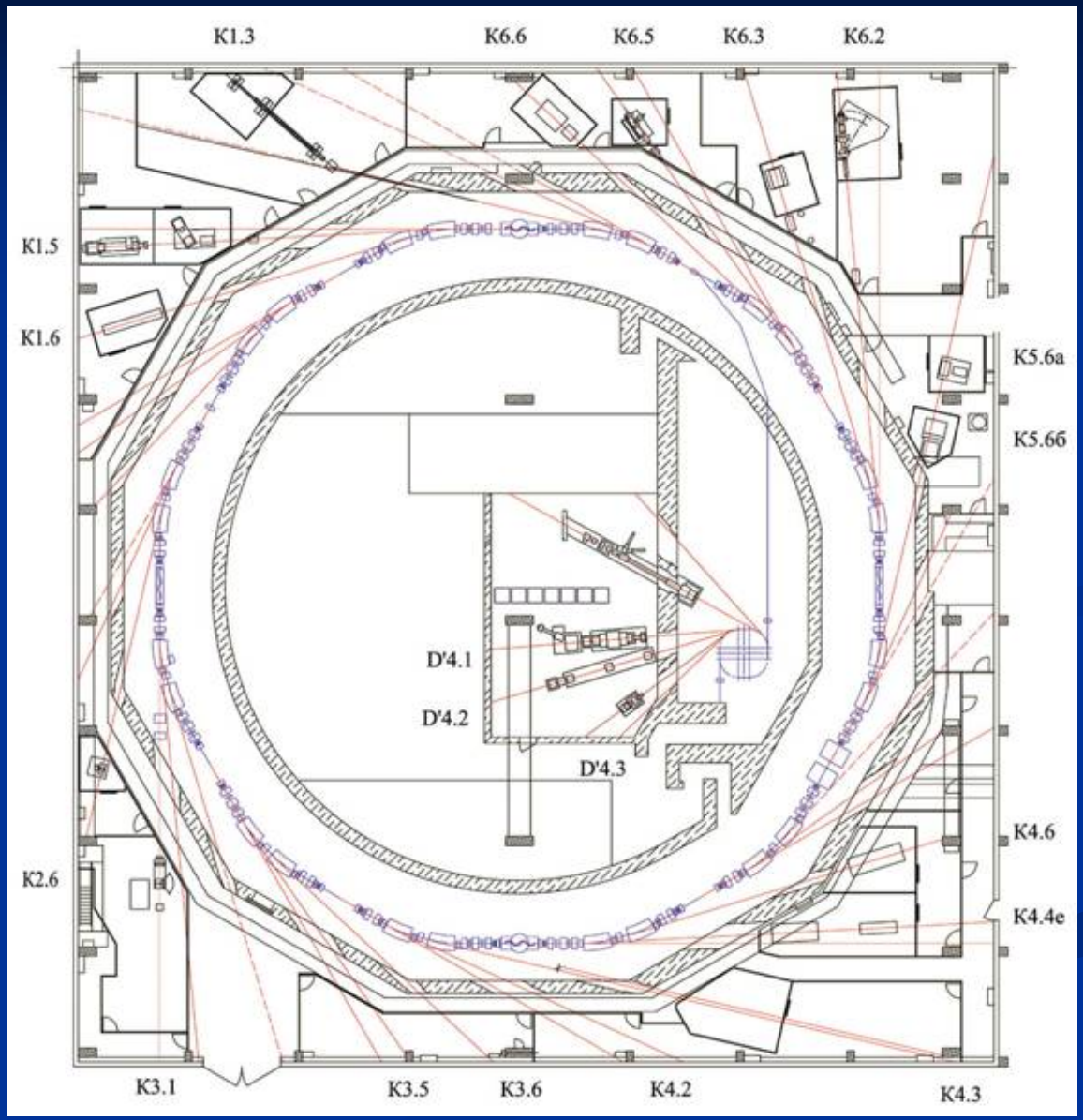
Wiggler



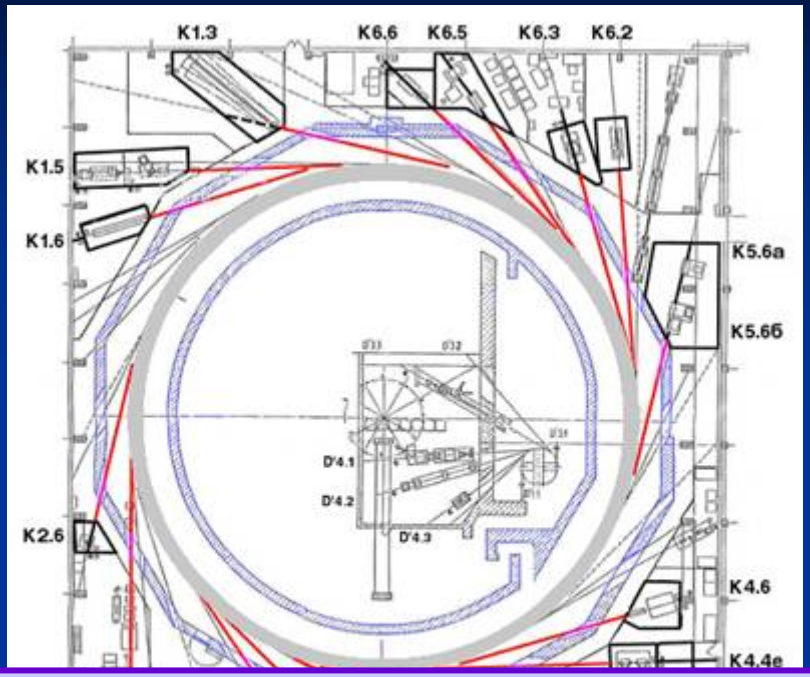
The source provides the synchrotron radiation (SR) in the wavelength range extending from 0.1 to 2000 Å.

Experimental stations

X-ray stations	
1	Protein Crystallography
2	Precise X-ray Optics
3	X-ray Crystallography and Material Science
4	Medical and Industrial Diagnostics
5	LIGA
6	EXAFS
7	Small Angle Scattering
8	Time-Resolved Small-Angle Diffraction
9	Refraction optics
10	Diffraction topography and tomography
VUV stations	
11	Photoelectron Spectroscopy
12	Optical Investigations of Dielectrics
13	VUV Luminescence and Absorption
X-ray stations under construction	
14	X-ray Structure Analysis
16	Surface Investigations (Molecular Beam Epitaxy)
17	Organic films (Lengmure-Blodgett)
18	Photon-Nuclear Reactions
19	High Pressure

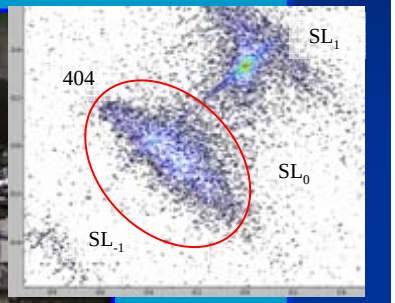


EXPERIMENTAL STATIONS



Precise X-ray optics

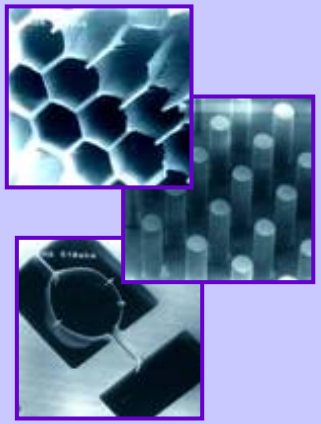
K 6.6



ω-2θ

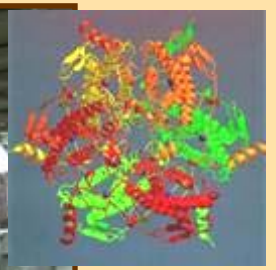
Deep X-ray lithography

K 6.3

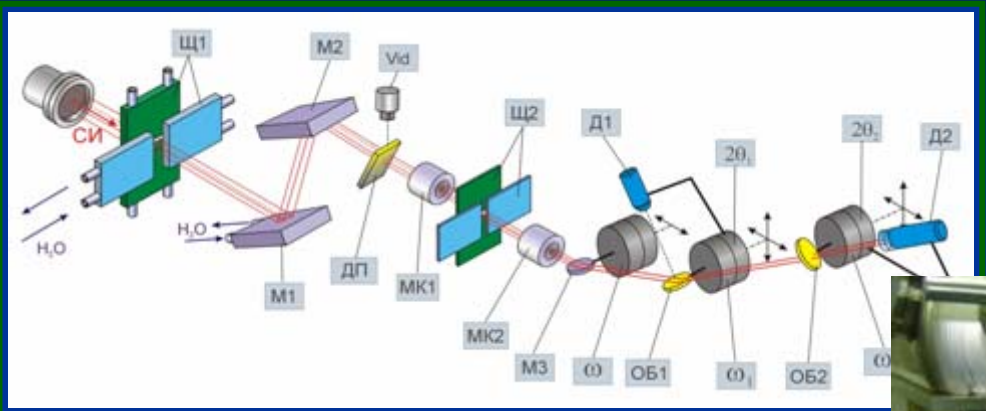


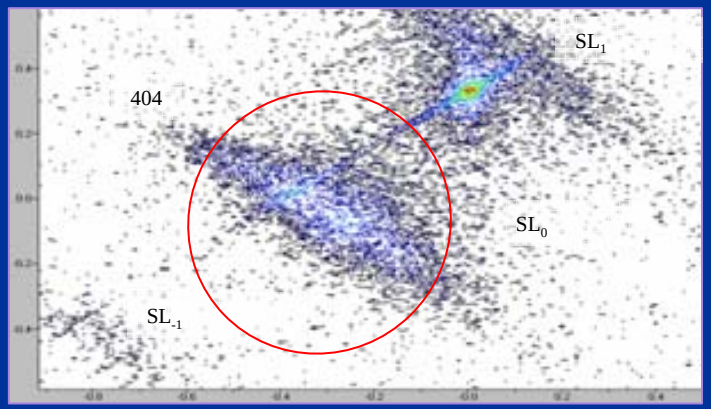
Protein crystallography

K 4.4 e



Station for Material Science and Crystallography

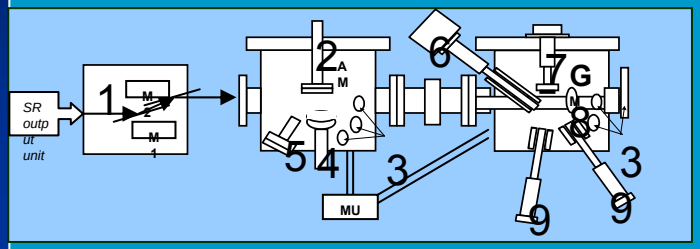


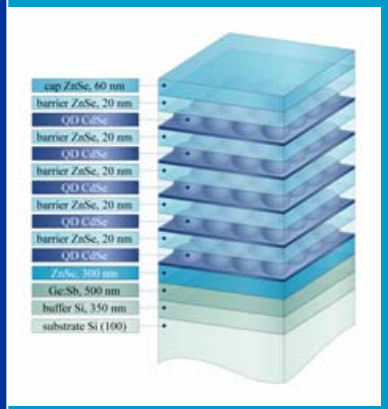


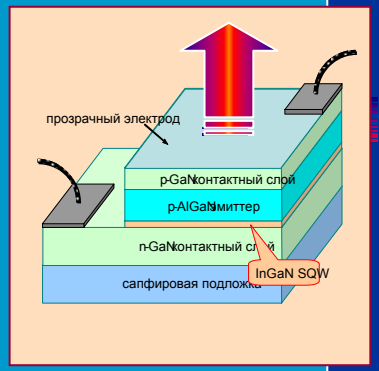
Diffuse scattering at quantum dots nanostructure in InAs/GaAs

Stations for Nanotechnology and Nanodiagnostics

Molecular Beam Epitaxy

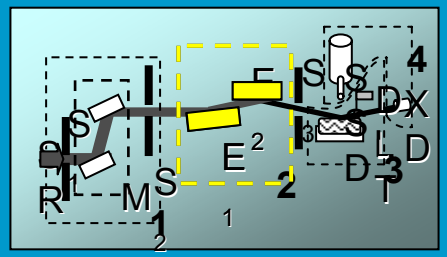


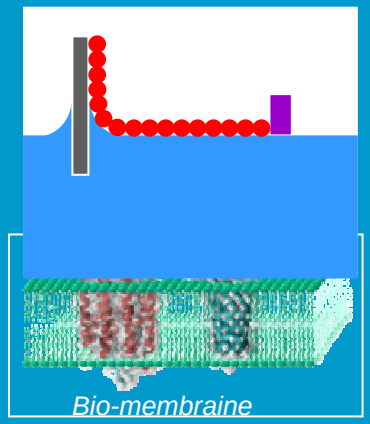


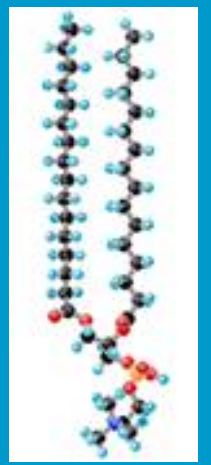


Heterostructure

Lengmur-Blodgett technology





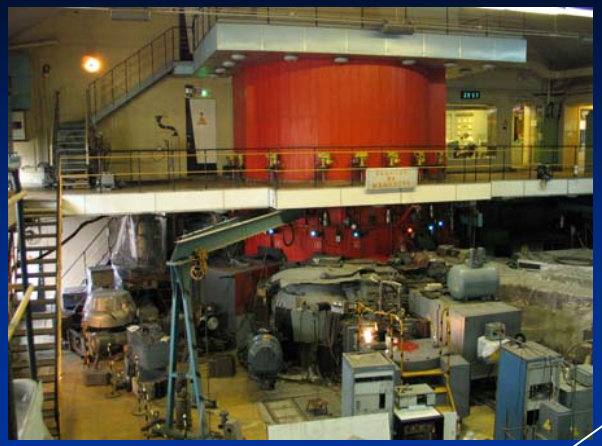


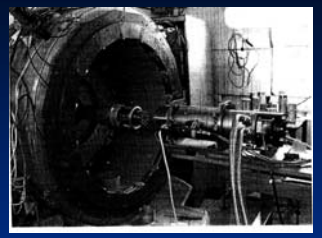
A special interest is given to the experimental stations for synthesis or structure diagnostics of organic and inorganic nanomaterials (nanotechnology).

Station for Molecular Beam Epitaxy

Neutron center on Reserch Reactor IR-8

ATOS





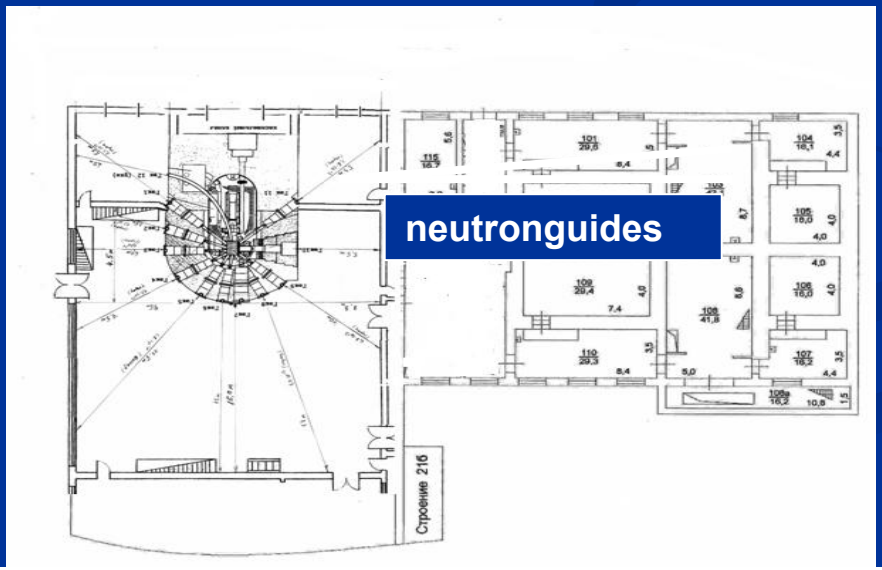
MEN

MOND

Inelastic scattering
Neutron diffraction
Small angel scattering
Neutron optics

STOIK

DISK



New instruments:
Reflectometer SANS,
High fields,
High pressure,
Very cold neutrons

Capillary
microbeam ~500 μ

Neutron diagnostics of amorphous and nanoscale materials

Problems:

Structure,dynamics,
phase transitions
in nanoscale systems

Behaviour of nanosystems
in a wide range temperatures,
pressure and dozes
of an irradiation

Properties nanosystems:
termostability
sorptional
mechanical
magnetic

Systems:
Metal
Carbon
Hydrocarbonic
Metal - hydrogen
Photon crystals

Neutron difractometer DISK

high pressure cell

Methods

receptions and researches

reactor irradiation
mechano-activation
melt spinning
hydroganization

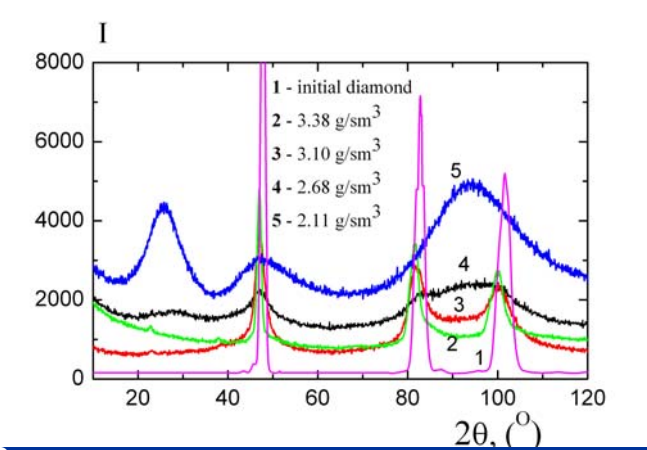
ball mill

Neutron diffraction
Inelastic scattering of neutrons
Small angel scattering
Polarized neutrons

Carbon nanoscale systems (diamond, fullerenes, graphite usw)

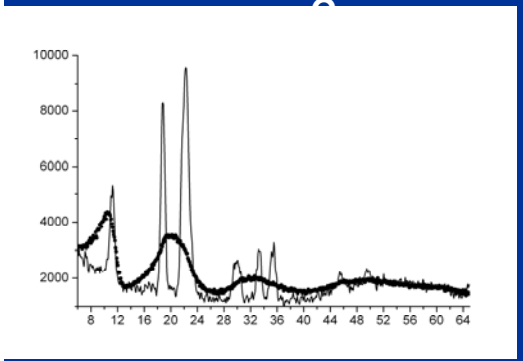
Short range in irradiated dimonds

Phase transition in nanoscale systems (polyamorphous transitions)

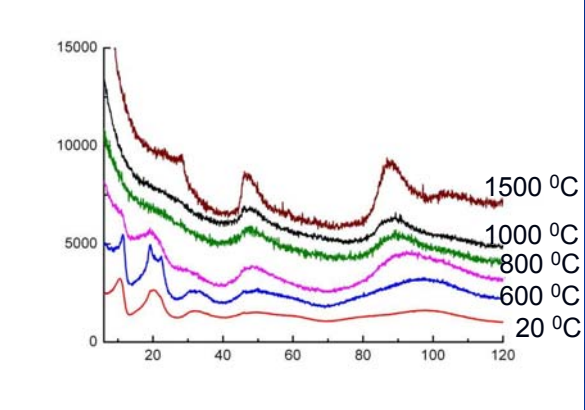


Transition from a diamond-like glass to a graphite-like glass upon change in density

Production of amorphous fullerenes (milling 50 hours)

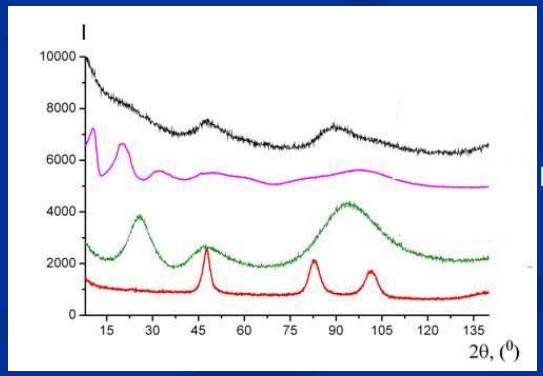


Annealing amorphous fullerenes



Termostability C_{60}
Cryst. 870 °C
Amorph. 1700 °C

Transition in amorphous fullerenes from molecular in atomic glass



Atomic glass
T=1300 K

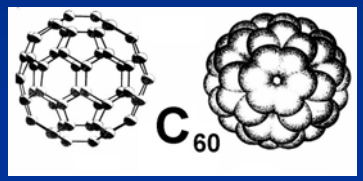
Molecular glass
T=300 K
Amor. graphite
T=300 K
nanodimond
T=300 K

Potential applications

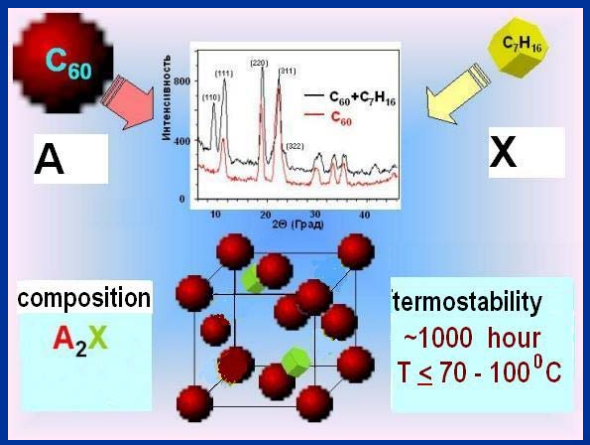
Reactor materials
Constructional materials

Alloy reactor materials with nanoscale fullerenes
Metal glasses on a basis the elements used in reactor technology
Nanoscale metal hydrides
Nanoscale fullerene hydrides

High-temperature H-containing moderators



Systems of the storage of combustible gases and fluids



Connections fullerenes with molecules of combustible gases and their derivatives

Sintering of detonation diamonds

Interaction nanoscale detonation diamond with amorphous fullerenes

New Facilities: **Scientific Technology Center of Nanothecnology**

- More than 100 sets of unique and the most modern research, experimental, metrological and the process equipment

- Clean rooms

The Structure of laboratories of Nanotechnology Centre

- Laboratory of structural researches and electronic microscopy of functional nanostructures and nanomaterials.
- Laboratory of physical and chemical properties of a nanostructures and nanomaterials surface.
- Laboratory of physical properties of functional nanoelements and nanopmaterials.
- Laboratory of development of methods of multilayered nanolithography.
- Laboratory of experimental methods of functional nanoelements, nanosensors and nanodevices production.
- Laboratory of radiobiology and biochips.
- Laboratory of Micro- and Nano- Electro Mechanics (including group of electroforming of metals).
- Laboratory of radiation material science and nanomaterials.
- Laboratory of theoretical researches of nanostructure physics (including group of nanosensor and functional nanoelements simulation).

Examples of New Investigation Equipment

- Two 300-keV electron microscopes "Titan"
- Focused Ion Beam "Helios NanoLab™"
- Electron Lithography and other lithography systems
- Materials Deposition and Etching systems
- Ion Implantation system
- Biology and Medical Investigation system

“Titan” Electron Microscope

Electron Microscope “Titan” provides the highest level of detail information available today—down to the sub-Ångström level, providing critical data for process development and materials research on a highly stable, easy-to-use platform. Titan is the next generation of a unique 300 kV range microscope for corrector and monochromator technologies.

“Helios NanoLab” FIB system

The World’s Most Advanced DualBeam™ Solution for Superior Sample Preparation, Imaging and Analysis in the Lab.

Electron Lithography system

The JBX-6300FS, equipped with a thermal field emission electron gun with a ZrO/W emitter, is an electron beam lithography system provided with the Vector Scan Method for beam deflection. The beam deflection employs 19bit DAC, and the accelerating voltage 25kV or 50kV or 100kV is selectable. The workpiece stage is driven by the step- and repeat-method, and up to 200 mm wafer can be loaded.

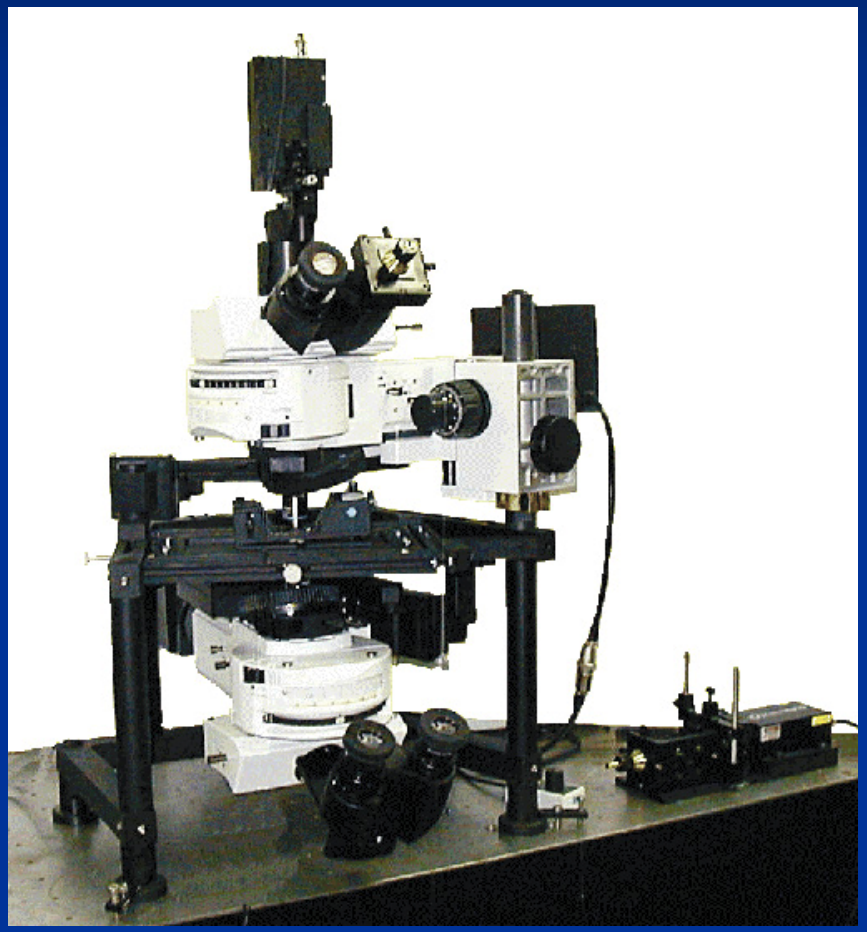
Coating system

The TF600 coating system is designed for increased levels of process capability. Its unique configurations of external pump, remote equipment rack and larger chambers provide greater flexibility. Combined with flexible base and top plate arrangements and the ease of a touch screen control system, the TF600 delivers new standards in vacuum coating.

Ion Implanter

The Optima HD is a high dose ion implanter that delivers precise and productive implants across a broad applications base, including source/drain, source/drain extension and poly-doping transistor forming applications. The Optima HD is also available with Hydrogen and molecular implant capabilities.

AFM and NSOM system



SPM modes:

- *AFM contact*
- *AFM Intermittent contact mode*
- *STM*
- *Electrical Measurements*

Near Field Modes (NSOM):

- *Reflection*
- *Transmission*
- *Collection*
- *Fluorescence*
- *Photo-Luminescence*

Far Field Methods:

- *Standard Microscope Imaging*
- *Fluorescence*
- *Confocal*

Conclusions

Russian Recearch Center “Kurchatov Institute” is the most powerfull sientific center in Russia in the Nanotechnology and Materials Sience area. Great experience in the field of materials production and their property examination together with a morden equpment will provide a challange of nanomaterials creation to build new nanoscale base devices.