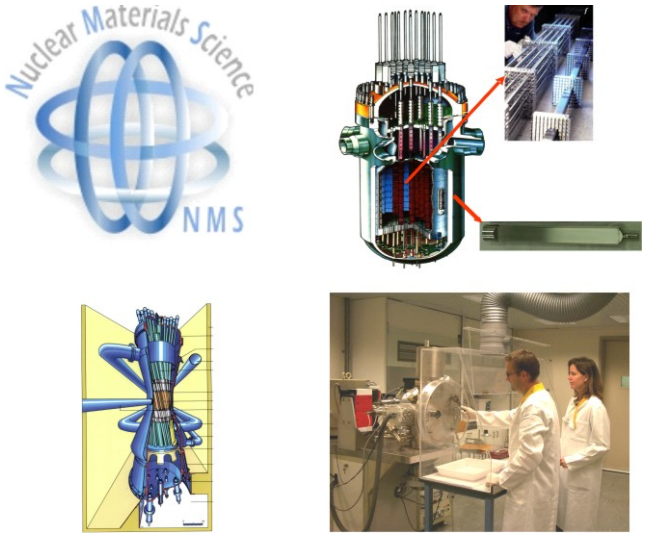
SCK·CEN

STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

INSTITUTE FOR

NUCLEAR MATERIALS SCIENCE



NMS develops and assesses new and existing materials for their suitability in nuclear applications. The research realises the objective scientific (physical chemical phenomenological) and technological (experimentally empirical) follow-up and prediction of the reliable functioning of the materials in the given working conditions.

GENERAL OBJECTIVE

The general objective of the institute for Nuclear Material Science is to develop and assess new materials (i.e. fuels, structural materials and radioisotopes) for their suitability in nuclear applications. The overall approach comprises the experimental characterisation of the materials behaviour when subject to irradiation, the improved scientific understanding thereof, and its implementation in numerical simulations that enable the behaviour of materials in a nuclear environment to be predicted. These activities aim both to safeguard our own expertise and to offer high added value services to the nuclear industry.

STRATEGIC PRIORITIES

- the scientific/technological evaluation of the performance and life span of materials used in existing power plants;
- the development and validation of materials for advanced fission reactor concepts (ADS-MYRRHA, GEN IV) and for fusion (ITER, DEMO);
- the qualification of evolutionary fuels for present day reactors;
- the development and qualification of new fuels for advanced reactor concepts (research reactors, ADS-MYRRHA, GEN IV);
- the development of new radioisotopes for medicine and the enhanced neutron transmutation doping of Silicon.

EXPERT GROUPS

The institute is divided into eight expert groups: three are concerned with the definition, design, guidance and analysis of the thematic research lines, four deal with the management, the development and the operation of the experimental facilities, whilst the last one provides the general support for the complex nuclear infrastructure.

The three expert groups that drive the programme lines perform the following research:

Structural Materials (SMA)

- assessment of the embrittlement of reactor pressure vessel steels for conventional nuclear power plants (NPP) – the group is responsible for the testing and analysis of surveillance capsules from Belgian and foreign NPP's, including the application of advanced surveillance methodologies such as specimen reconstitution and direct fracture toughness testing;
- evaluation of the embrittlement and the stress corrosion cracking resistance of core structural materials used in present day nuclear systems and anticipation for new future nuclear systems (high Cr steels for ADS, RAFM for fusion);
- better fundamental understanding of irradiation damage mechanisms on the atomic scale by Multi-Scale Modelling;
- development and validation of mathematical codes predicting the material properties and their evolution in nuclear environment.

Fuel Materials (FMA)

- qualification of nuclear fuel for present day reactors, either by direct bilateral contractual research or by participation in international research consortia;
- development and qualification of new fuels (MTR, ADS-MYRRHA, GEN IV), including 'targets' for transmutation scenarios;
- better fundamental understanding of irradiated fuel phenomena through dedicated solid state research of actinide based systems;
- better integral understanding of irradiated fuel phenomena by defining, operating and analysing separate effect tests (e.g. parametric instrumented irradiations);
- development and validation of a mechanistic thermo-mechanical fuel performance code applicable to new fuel types.

Materials Chemistry (MAC)

- conduct radiochemical research to support the production of new medical and industrial radioisotopes;
- studies into liquid metal coolant chemistry;
- provision of scientific chemical services to the other expert groups , e.g. local chemical analysis to support corrosion studies.
- The institute operates four major infrastructural tools that offer high added value services, on a competitive basis, both towards internal (research lines from within all SCK•CEN institutes) and external clients.

Mechanical and Corrosion Analysis (MCA)

- characterizes experimentally the mechanical properties of both unirradiated and irradiated materials by tensile, impact, fracture toughness, fatigue and creep testing, both in air and aggressive environments (corrosion tests);
- operates sample design equipment, including reconstitution techniques.

Microstructural and Non-destructive Analysis (MNA)

- operates a large hot-cell infrastructure for the non-destructive screening of fuel rods (up to industrial lengths) for all major fuel performance indicators;
- operates fuel refabrication/instrumentation equipment to fabricate short rodlets from full-size rods – that can be accommodated within research reactors (BR2 – VENUS) – and to encapsulate fuel rod remnants for disposal;
- operates a quite extensive set of microscopes dealing with both the µ-structure (OM, SEM, TEM, XRD) and µ-chemistry (SEM-EDX, EPMA, XPS) of materials, backed up by appropriate sample preparation tools.

Radiochemical Analysis (RCA)

- provides accurate, thorough (radio-)chemical analysis of materials from the nuclear fuel cycle, such as fresh and irradiated nuclear fuels, reactor materials and radioactive wastes, using a wide range of (radio-)analytical instrumental techniques backed up by extensive separation methodologies;
- analyses typical nuclear related physico-chemical material characteristics, such as gas build up in solids and the associated material swelling;
- supports the BR2 reactor with water control analyses;
- supports the research programmes by determining the (radio-)chemical composition of materials and process liquids;
- operates a large infrastructure for chemical sample preparation, including laboratories equipped with hot cells, gloveboxes and fume cupboards, to support experimentation on low to highly radioactive samples.

Belgian Reactor 2 (BR2)

- operates the BR2 research reactor;
- serves the medical industry by the production of radioisotopes and the electronics industry by silicon doping;
- accommodates experimental rigs to test fuels and structural materials for different reactor types.

Infrastructure Operation (IOP)

This group takes care of the mechanical and electrical/electronic aspects of all research infrastructures within all institutes and manages the nuclear materials flows within the institute (transports, accountancy, waste).

To accomplish its research programme lines the institute co-operates closely with the institute of advanced nuclear systems (ANS) which designs and builds the reactor experimental rigs and which provides instrumentation and n-physics expertise and support to the scientific irradiation experiments.

Contact

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