STUDY IN FRANCE

RESEARCH IN NANOSCIENCES

With more than 5,300 researchers and 240 laboratories working in the nanosciences and nanotechnologies, French institutions are engaged in a great many nano-research projects in the broad fields of electronics, communications, materials, energy, biotechnologies, pharmacology, medicine, health, and the environment. Albert Fert shared the 2007 Nobel prize in physics with German Peter Grünberg for their independent discoveries of giant magnetoresistance and their contribution to the development of spintronics, which made possible the magnetic readers used in today's computers.

With the research infrastructure built since the 1990s, France is one of the leaders in basic research in the nanosciences. The country ranks second in Europe, after Germany, in the amount invested in nanoscience research, and fifth in the world in number of publications in the field.

KEY SECTORS FOR APPLICATIONS OF NANOTECHNOLOGY RESEARCH

Electronics: Microelectronics, embedded electronics (telephone, touchscreen tablet, computer, home appliances), ITC (quantum computer, nanotransistors), and flat screens, among others.

Energy: lithium-ion batteries and hydrogen cells for increased autonomy of electric cars and motors, nanocomponents.

Environment: nanometric filtration membranes (water purification), catalytic converters, organic chemistry (hydrocarbons, oxidation).

Materials: nanotubes, nanoparticles (paint, plastic, textiles), nanopowders, nano-emulsions and -pigments (sunblocks, skin care).

Medicine: nanocapsules, nanoparticles, nanomaterials (genetherapies, tissue repair in regenerative medicine), nanostructures (allergy-related tests, molecular tests and markers), nanometric systems (analysis of substances in blood), implanted nanostructured biomaterials, biochips (genetic analysis).

Nanometer: a billionth of a meter, 0.000,000,001 meter.

Nanotechnology is the study of phenomena and the manipulation of materials at the atomic, molecular, and macromolecular levels, where properties differ significantly from those observed at larger scales.

Nanotechnologies cover the design, manufacture, and specification of nanostructures integrated within other devices, thereby making possible new applications. The success of these nanostructures relies on tight control of the shape and size of materials at nanometric scale.

MAJOR RESEARCH ORGANIZATIONS

COMPETITIVENESS CLUSTERS

http://competitivite.gouv.fr

6 centers of competence in the nanosciences, C'Nano were established in 2004. The C'Nano centers count on a network of firms and institutions of higher education to support their work on technological innovations needed by industry.

> **Lyonbiopôle:** Lyonbiopôle is developing products and services around miniaturized intelligent solutions (micro-nanotechnologies and embedded intelligence software) for industry.
www.lyonbiopole.com

> **Minalogic:** located in Grenoble, Minalogic also offers miniaturized intelligent solutions (micro-nanotechnologies and embedded intelligence software) for industry.
www.minalogic.com

> **Microtechniques:** located in Besançon, Microtechniques is built around technology know-how derived from, among other things, watchmaking. Its products are relevant to chip cards, telephones, remote broadcast relays, parameters, satellites, pacemakers, gears, control panels, and aircraft and automobile engines.
www.polemicrotechniques.fr

> **POPSUD (optics and photonics):** located in the Provence-Alpes-Côte d'Azur region, POPSUD specializes in complex optical and imaging systems designed for demanding environments.
www.popsud.org

> **S2E2 (electrical energy systems and sciences):** serving the Centre-Limousin regions, the S2E2 cluster performs work at every stage of the electrical energy value chain.
www.s2e2.fr

> **SCS (secure communication solutions):** operating in the Provence-Alpes-Côte d'Azur region, the SCS competitiveness cluster targets equipment and software for transmitting, exchanging, and processing data securely and reliably.
www.pole-scs.org

THEMATIC ADVANCED RESEARCH NETWORKS (KNOWN AS RTRAS)

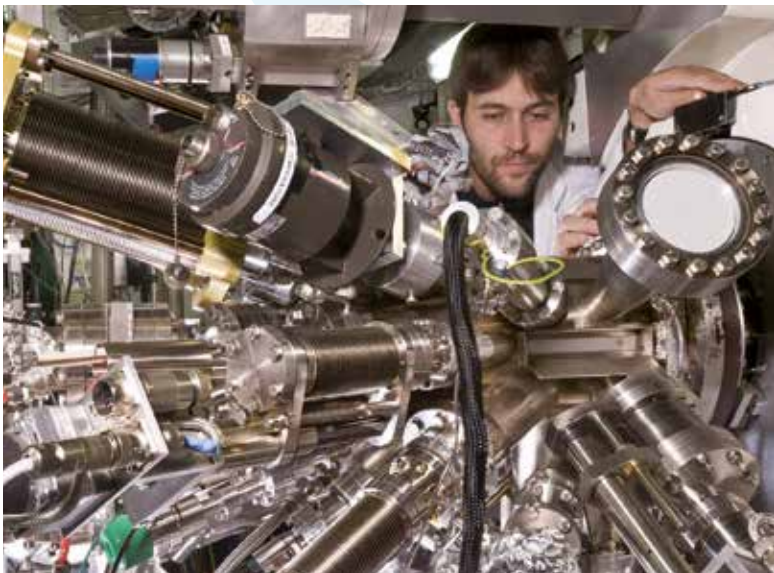
www.enseignementsup-recherche.gouv.fr >Stratégie

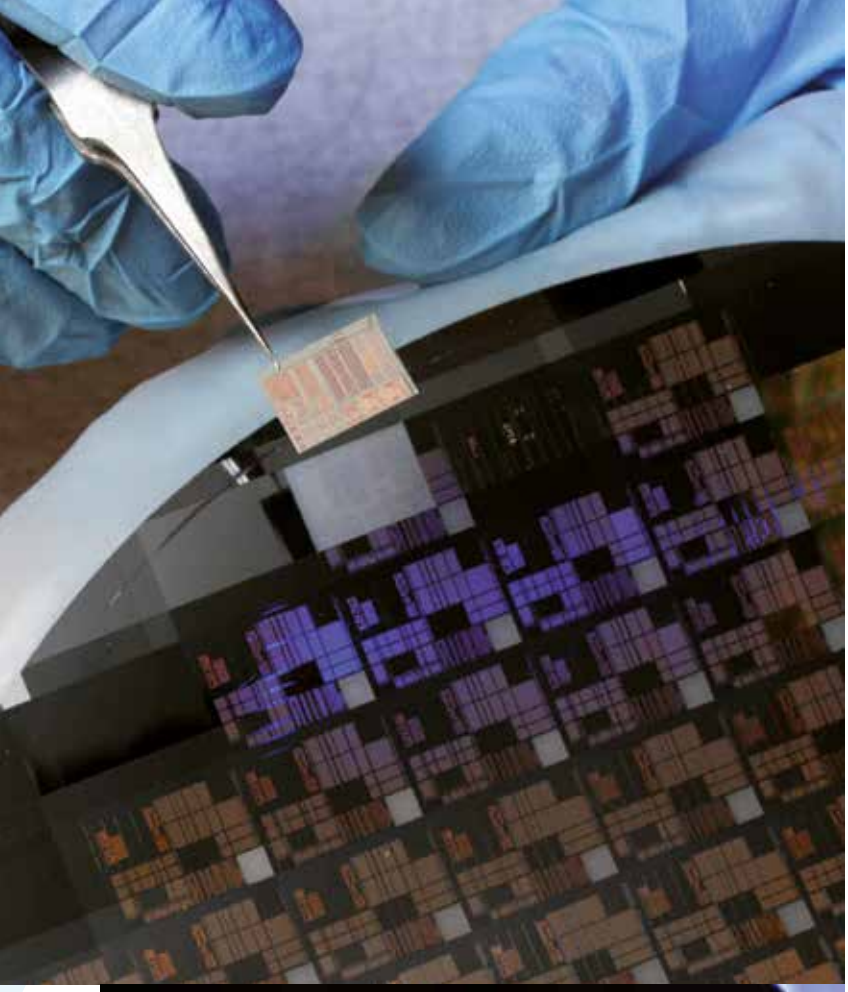
RTRAs are made up of research laboratories pursuing a shared strategy toward a common scientific objective. Three of France's 13 RTRAs deal with aspects of the nanosciences:

> **Grenoble nanosciences network** This RTRA brings together the CNRS, the French atomic and alternative energy commission (CEA), the Institut Polytechnique de Grenoble, and Université Joseph Fourier in their nano-related work in quantum electronics, magnetism, photonics, materials, the life sciences, measurement and description, and modeling. www.fondation-nanosciences.fr

> **Orsay physics triangle** The Orsay physics triangle brings together the laboratories of the Palaiseau-Orsay-Saclay region for work on specific themes (optics, spintronics-magnetoelectronics, nanophysics) that benefit from the use of very large research instruments like the Soleil particle accelerator, the neutron reactor at the Léon Brillouin national laboratory for neutron diffusion), or the high-powered lasers at the intense laser laboratory (LULI) on the campus of the École Polytechnique, the wave and acoustic laboratory (LOA) in Palaiseau), and the CEA. The Orsay physics triangle is the home base of French researcher Albert Fert, winner of the 2007 Nobel prize in physics.

> **CIRFC (The Strasbourg international center for research at the frontiers of chemistry)** Founded by Université de Strasbourg, the CNRS, the BASF companies (world leaders in chemistry), and Bruker (high-tech instrumentation), CIRFC is a multidisciplinary center that grapples with all aspects of chemistry at the interface with physics, materials, and biology. www.icfrc.fr





INSTITUT CARNOT

www.instituts-carnot.eu

The Carnot label is awarded to public research bodies that combine basic research with an active policy of research partnerships with the world outside academia. Of the three Carnot Institutes working in the nanotechnologies, two—LAAS and CEA/LETI—have already been mentioned. The third is STAR (science and technology for research applications), located in the Aix-Marseille university complex. STAR consists of 12 research laboratories affiliated with the university and the CNRS that are engaged in R&D (Research and Development) projects on industry-relevant topics such as energy, transportation, electronics, aeronautics, the environment, and health.

www.instituts-carnot.eu/fr/star

USEFUL LINKS

- ABS, Algorithmics and structural biology for macro-molecular systems: **www.inria.fr/equipes/abs**
- Database of nanomaterials organizations in France: **www.nanomateriaux.org**
- Admission of doctoral candidates and postdoctoral fellows, RTRA Grenoble: **www.fondation-nanosciences.fr/RTRA/fr/6/recrutement.html**
- Center for competence in the nanosciences of the Rhône-Alpes region: **www.cnano-rhone-alpes.org**
- Research center for vegetal macromoleculars (CERVAM): **www.cermav.cnrs.fr**
- CIME nanotech, Universitary center in microelectronics and nanotechnology: **www.cime.inpg.fr**
- "Des nanotechnologies à la biologie de synthèse," Annales des Mines 2010: **www.annales.org/ri/2009/ri_fevrier_2010.html**
- European School On Nanosciences & Nanotechnologies (ESONN): **http://esonn.fr**
- FMNT, micro- and nanotechnology research federation: **http://fmnt.online.fr**
- FEMTO-ST (Franche-Comté institute for the science and technology of electronics, mechanics, thermics, and optics): **www.femto-st.fr**
- Framework program of the European Commission: **http://cordis.europa.eu/nanotechnology/**
- French group for polymer research and applications: **www.gfp.asso.fr**
- French ministry of the economy, finance, and industry: **www.industrie.gouv.fr/portail/politiques/index_nanotech.html**
- Grenoble Institut des Nanosciences (GIN): **http://neurosciences.ujf-grenoble.fr**
- ICON (International Council of Nanotechnology): **http://icon.rice.edu**
- INAC (nanosciences and cryogenics institute): **http://inac.cea.fr**
- Institute for New Energy Tecnologies: **www-liten.cea.fr**
- Laboratoire des technologies de la microélectronique: **www.ltm-cnrs.fr**
- MESCAL, calcul haute performances pour les nanoscience: **www.inria.fr/equipes/mescal**
- Micro & nanomagnetism group: **http://neel.cnrs.fr** >Le Laboratoire>Équipes de Recherche>MNM
- MINATEC, innovation campus for micro- and nanotechnologies: **www.minatec.com**
- Nano-D, modélisation et simulation de nano-systèmes: **http://nano-d.inrialpes.fr**
- Nanofab, centrale de développement de procédés de micro et nanofabrication pour la recherche fondamentale: **http://neel.cnrs.fr** >Le Laboratoire>Pôles technologiques>Nanofab
- Nano-Micro technologies club: **www.clubnano.asso.fr**
- Nanomat, an international network for the study of nanomaterials: **www.nanomat.fr**
- NanoLyon, the technology platform of the Lyon region: **http://inl.cnrs.fr** >Plateforme NanoLyon
- NANOFORUM, the European nanotechnology forum: **www.nanoforum.org/**
- Nano Safe, a consortium for the production and utilization of nanomaterials: **www.nanosafe.org**
- Nanosciences foundation: **www.fondation-nanosciences.fr**
- Nanospintronique et transport moléculaire (NanoSpin): **http://neel.cnrs.fr** >Le Laboratoire>Équipes de Recherche>NanoSpin
- Plateforme Technologique Amont (PTA): **http://pta-grenoble.com**
- STMicroelectronics: **www.st.com**
- Surfaces, Interfaces et Nanostructures (SIN): **http://neel.cnrs.fr** >Le Laboratoire>Équipes de Recherche>SIN
- Théorie et Nanosciences (ThNano): **http://neel.cnrs.fr** >Le Laboratoire>Équipes de Recherche>ThNaNo

FRENCH RESEARCH PORTAL

WWW.CAMPUSFRANCE.ORG/EN/RESEARCHER

A UNIQUE, **ONLINE-ACCESS INFORMATION POINT** FOR LOCATING RESEARCH PROJECTS

UNDERSTANDING FRENCH RESEARCH

> Understanding how PhDs operate in France;
> Knowing how to start and finance a PhD;
> Applying to international research programs (Hubert Curien Partnerships, *Make Our Planet Great Again*).

DIRECTORY OF DOCTORAL INSTITUTIONS

Point of entry for starting a PhD and the 270 doctoral institutes organizing and supervising doctoral training.
> Search by key words, regions, and disciplines;
> Comprehensive information on doctoral institutions: Research areas, criteria and points of contacts for admission, welcome mechanisms, proposed topics, current financing, international dimension, and points of contacts for associated research laboratories;
> Access to fields offered by each doctoral institutions.

42 doctoral schools in nanosciences accessible at:

https://doctorat.campusfrance.org

PhD TOPICS, LABORATORY INTERNSHIPS, AND POST-DOCTORAL STUDIES:

> Offers financed through doctoral contracts, Industrial agreements for training through research (CIFRE), and specific offers devoted to programs financed by foreign governments;
> Offers for internships for experience in laboratory research;
> Post-doctoral offers for work in French laboratories;
> A detailed financing mechanism for each research offer (PhD topics, post-docs, and internships);

Almost 100 offers made public in nanosciences each year, accessible at:

https://doctorat.campusfrance.org/phd/offers

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