TASK #2

Produced and characterized pellets until summer 06 for SPES DT project

SPES: A Mid-term Facility based on a 40 MeV proton Driver and on the Multi-Slices Direct Target concept

Target production

PHILOSOFICAL APPROACH

1) A primary topic in the development of the generation of Radioactive Ion Beams (RIB) is the production of targets characterized by:

high production yield short release times high thermal resistance

2) These capabilities are strongly influenced by many physical and chemical properties of the targets

(e.g. purity degree, grains sizes, grains distributions, grains stoichiometry, porosity etc..)

3) It becomes essential to produce targets with:

a) Strict control of the production method → high reproducibility

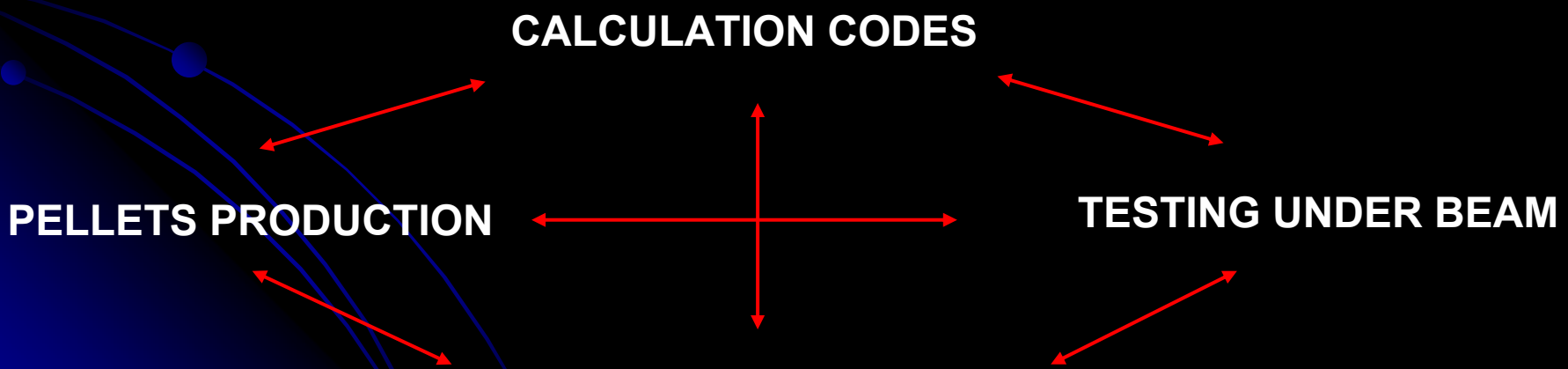
b) Deep characterization of the samples → good knowledge of the produced samples properties

Target typologies

1) THE "PARTIALLY" COMPLETE PHASES OF SUITABLE ACTINIDE TARGETS PRODUCTION

- ✓ Strict control of the production process
- ✓ In-depth characterization of the physical properties of the produced samples
- ✓ Handling of the produced samples (reactivity troubles)

2) THE COMPLETE PHASES OF SUITABLE ACTINIDE TARGETS PRODUCTION



Target typologies

THE MAIN GOAL OF TASK 2 IS THE PRODUCTION OF ACTINIDE TARGETS (UCx, ThCx..)

1) Phase 1→ SiC Pellets No Chemical & Radiologic problems

2) Phase 2→ LaC_2 Pellets Some Chemical problem of UCx (reactivity with oxygen (pyroforic))

→ **SIMILAR CHALLENGES WITHOUT RADIOACTIVITY**

3) Phase 3→ UCx Pellets Chemical & Radiologic problems (pyroforic and contamination)

Phase 1: SiC pellets

1) PELLETS PRODUCTION:

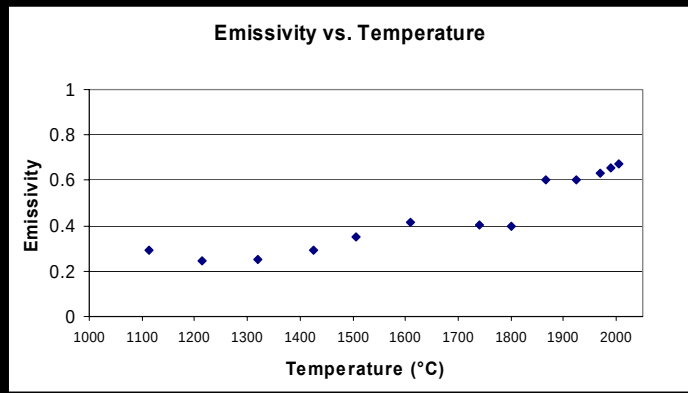
PURCHASED BY THE SAINT GOBAIN
(SiC Hexoloy SE)

Material	Hexoloy SE SiC
Maximum Use Temperature	1900°C
Flexural Strength (MPa) @ Room Temp @1450°C @1600°C	 300 370 410
Density (g/cc)	3.07
Apparent Porosity (%)	0.6
Modulus of Elasticity (GPa) @20°C @1200°C	 350 300
Thermal Conductivity (W/mK) @ 1200°C	30
Coefficient of Thermal Expansion	4.02 x 10^{-6}/°C

2) PELLETS CHARACTERIZATION

HIGH TEMPERATURE TESTS

EMISSIVITY TESTS



T= 2000 °C
E= 0,7 ± 0,05

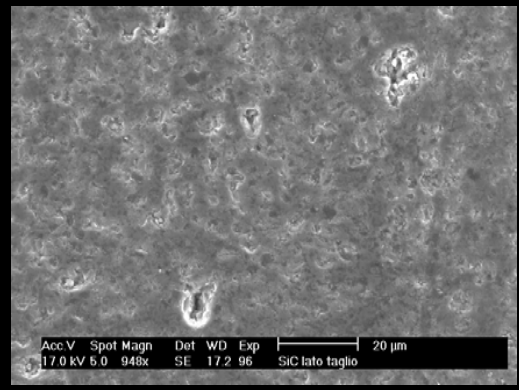
Mass before treatment: 800,9 mg
Mass after treatment: 800,8 mg

→ No weight loss

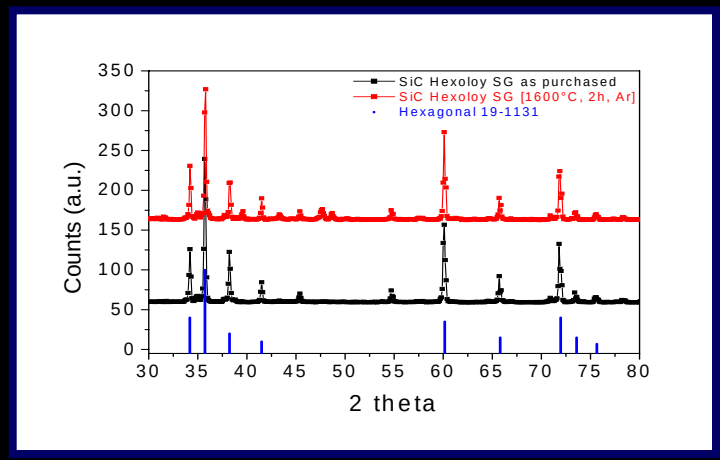
Phase 1: SiC pellets

2) PELLETS CHARACTERIZATION

SEM ANALYSIS



XRD ANALYSIS



3) TESTING UNDER BEAM

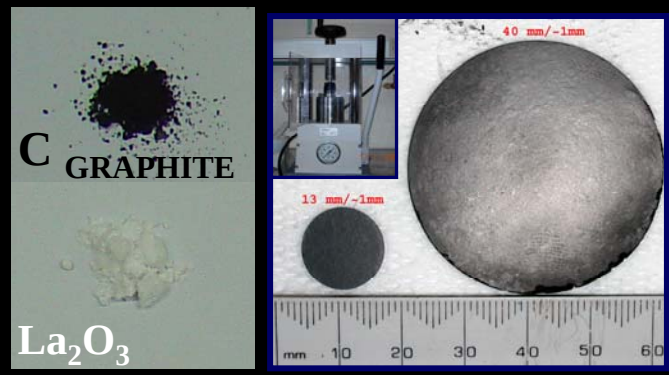
(planned at ORNL in the first part of 2007 (January-March))

4) PROBLEMS

NO PROBLEMS UNTIL NOW

Phase 2: [LaC_2 + C] pellets production

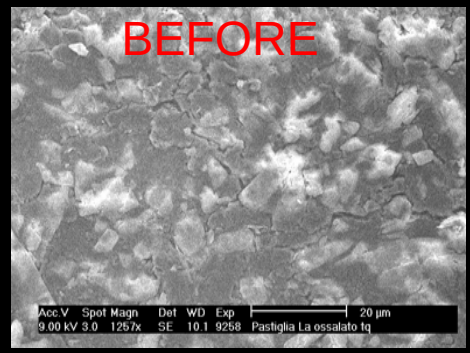
THE LaC_2 PELLETS PRODUCTION CONSISTS IN TWO PHASES:
GREEN PELLETS PRODUCTION + THERMAL TREATMENT

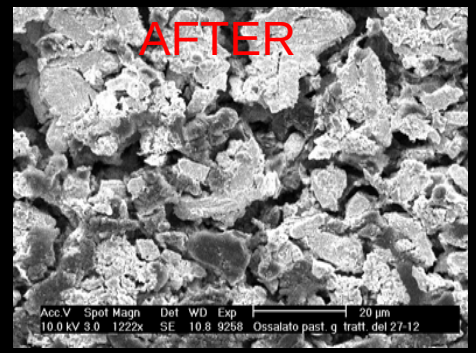


1) PELLETS PRODUCTION:

A) PRODUCTION OF STARTING PELLETS:

a) PRODUCTION OF OXIDE PELLETS



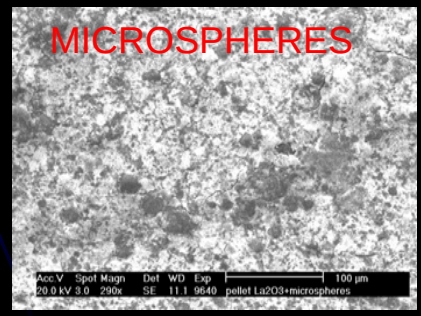


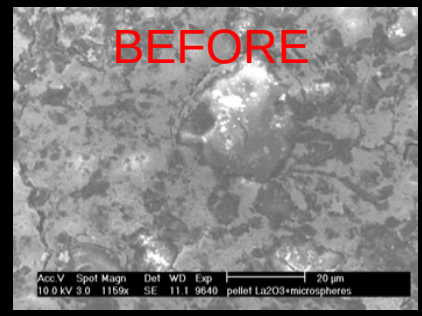
b) PRODUCTION OF OXALATE PELLETS:

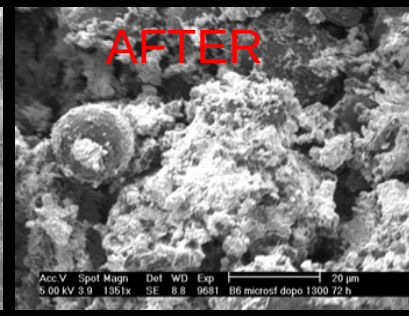
NOT MECHANICALLY STABLE

c) PRODUCTION OF OXIDE PELLETS WITH PEHOLIC MICROSPHERES:

MICROSHERES DO NOT PARTECIPATE IN CARBURIZATION PROCESS







Thermal treatments

B) THERMAL TREATMENT OF THE STARTING PELLETS

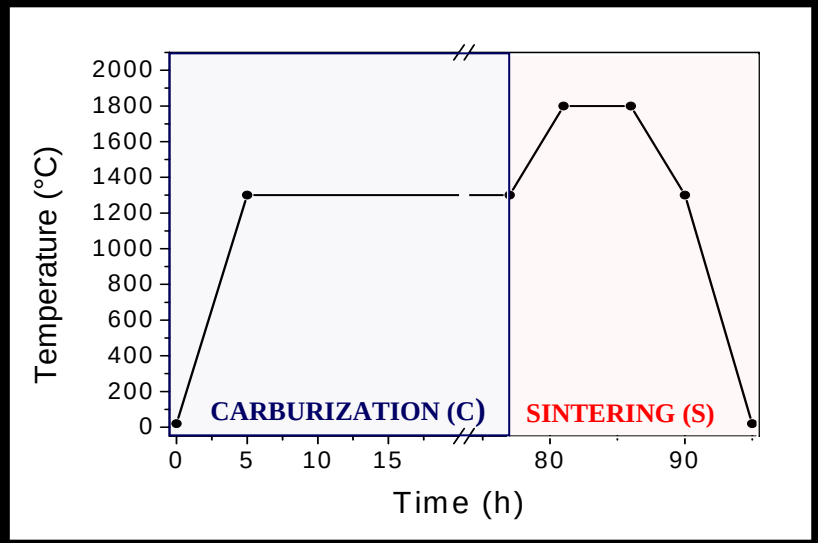
a) CARBURIZATION OF THE STARTING PELLETS

$$La_2O_3 + 11C \rightarrow 2LaC_2 + 4C + 3CO \uparrow$$

(Theoretical mass loss: 18.5%)

b) SINTERING OF THE CARBURIZED PELLETS

(INFLUENCE THE MECHANICAL PROPERTIES, THE GRAINS SIZES AND THE POROSITY OF THE FINAL PELLETS)



The furnaces

LNL (vacuum, < 1600 °C)

TRENTO (Ar, > 2000 °C)

LNL (vacuum, > 2000 °C)

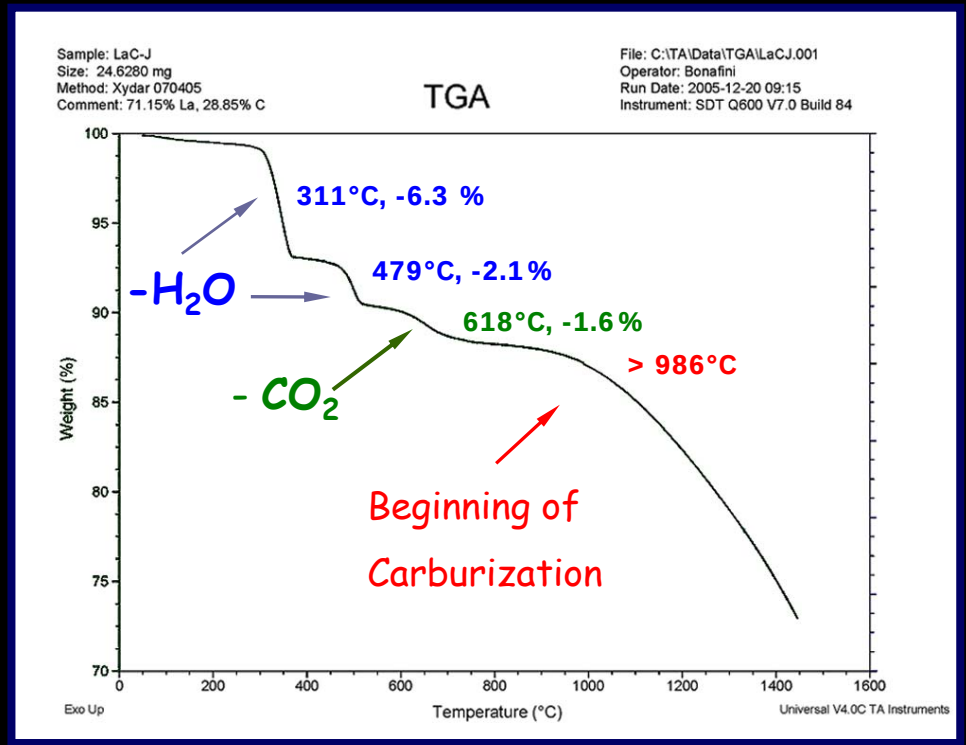
Phase 2: thermal treatment control

1) Strict control of the temperature values and temperature ramps (by means of a thermocouple and double frequencies pyrometer);

2) Monitoring of the chamber pressure during the thermal treatment
(in order to check the evolution of the reaction product (CO))

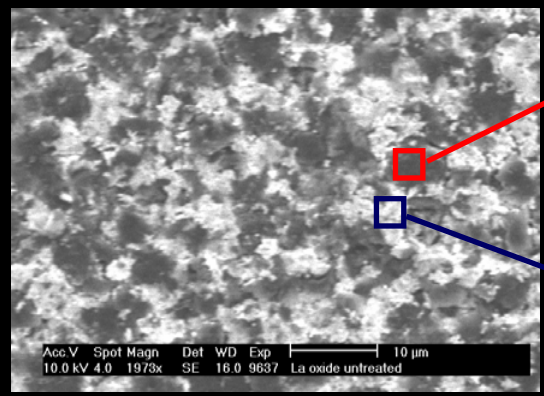
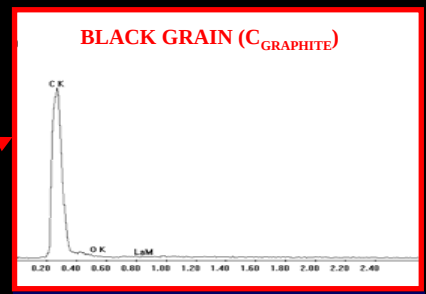
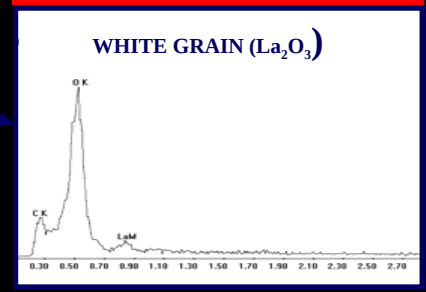
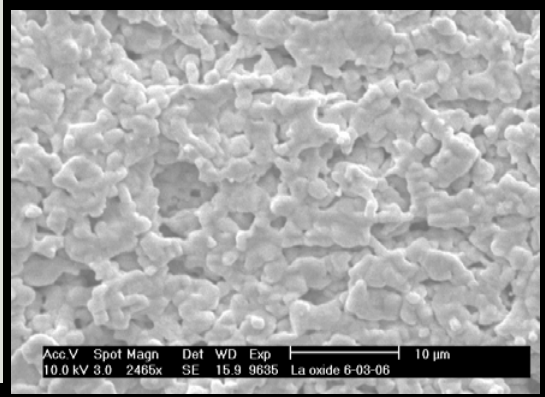
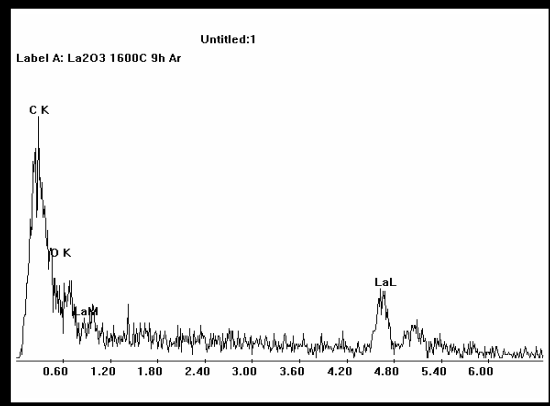
3) Monitoring of gaseous species evolved during the thermal treatment by means of a mass spectrometer connected to the furnace vacuum chamber

4) Control of the weight of the pellet during the thermal treatment (in order to have a very accurate control of the occurring reactions)

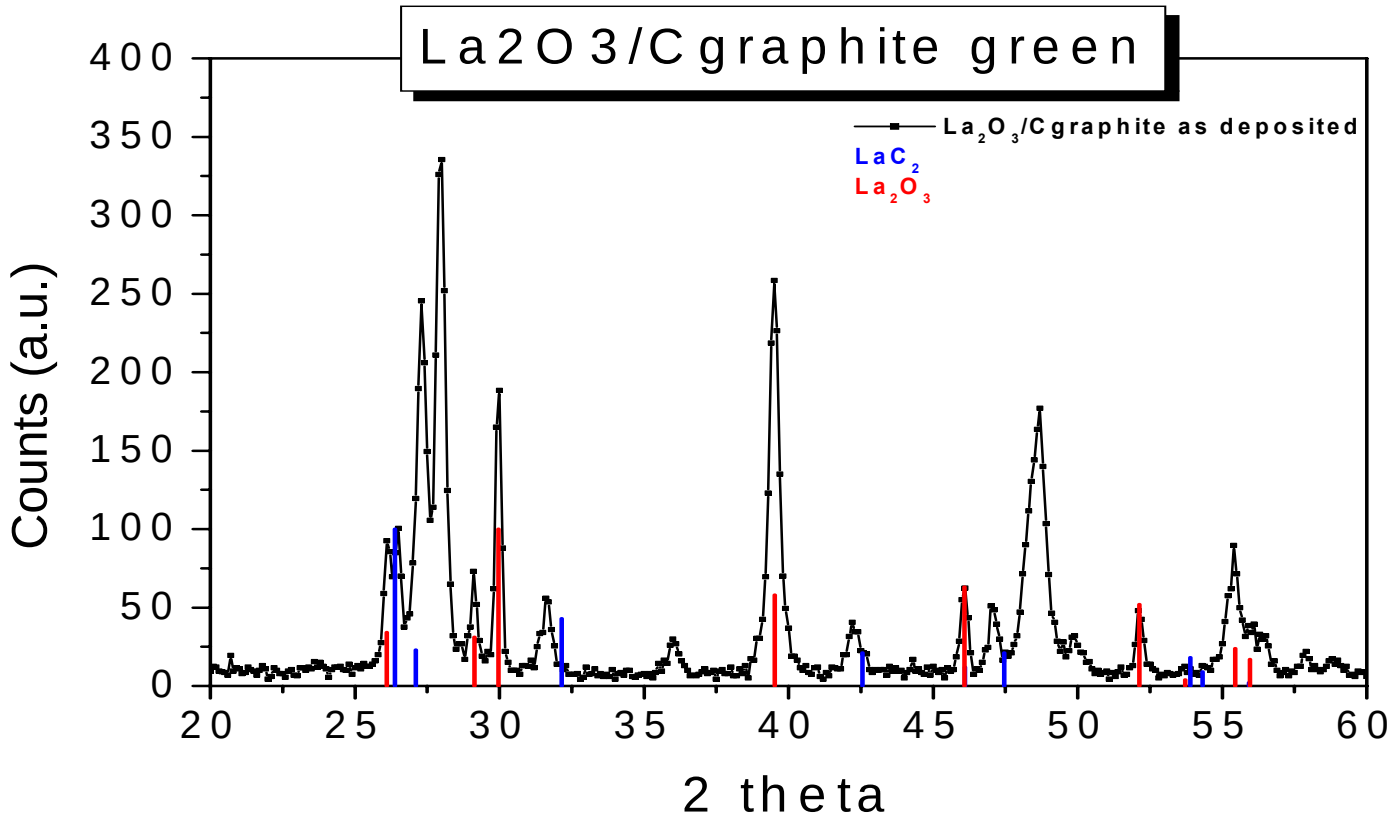


Phase 2: characterization of pellets

Commonly used techniques

	LOOK	SEM pictures	EDS analysis
BEFORE thermal treatment			 
AFTER thermal treatment			

Not commonly used techniques: the XRD patterns

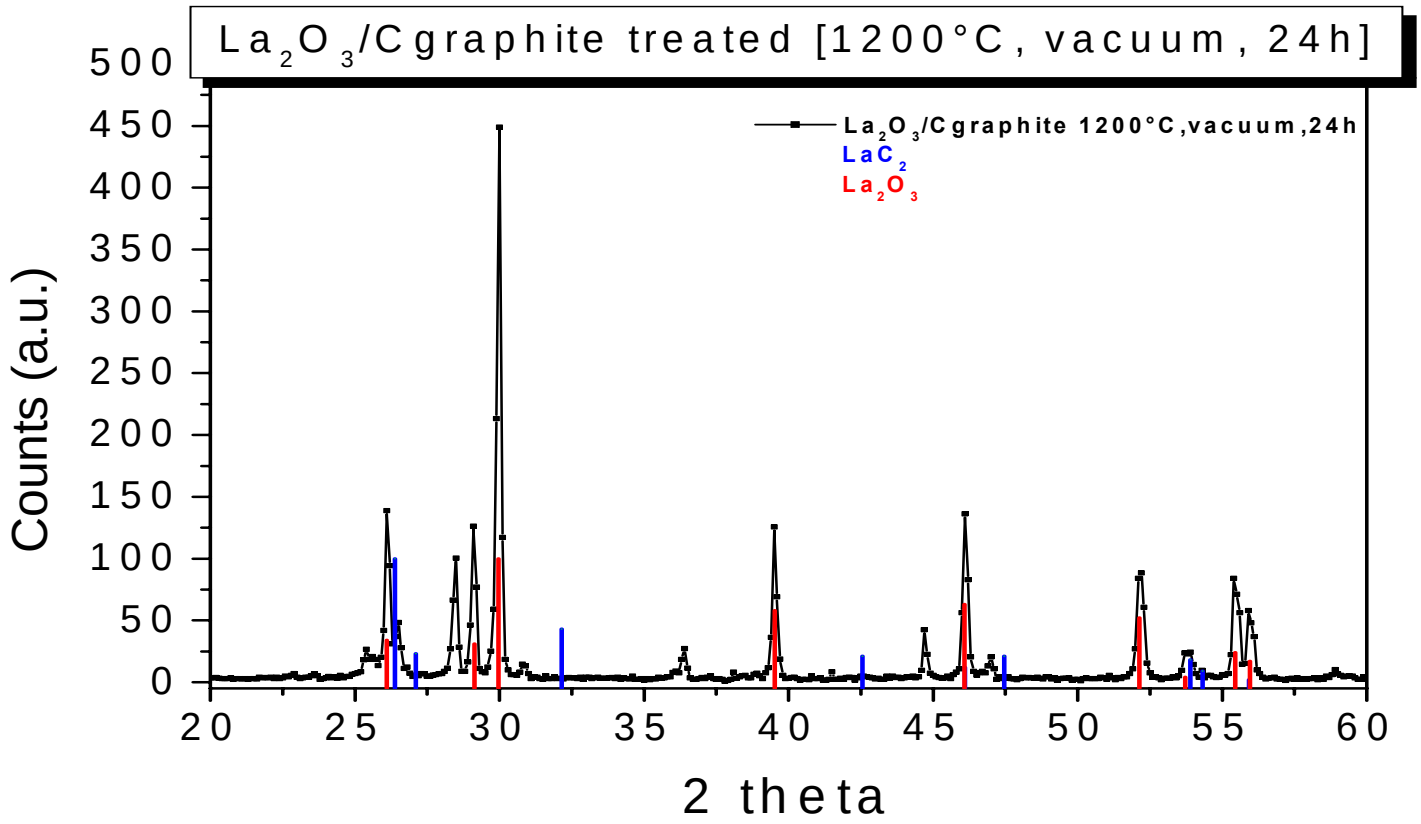


1) THE SAMPLE SHOWS THE PRESENCE OF LA_2O_3 (SEVERAL LANTHANUM OXIDE PEAKS ARE MANIFEST)

2) THE SAMPLE SHOWS ANY PRESENCE OF LAC_2 (NO LANTHANUM CARBIDE PEAKS ARE VISIBLE)

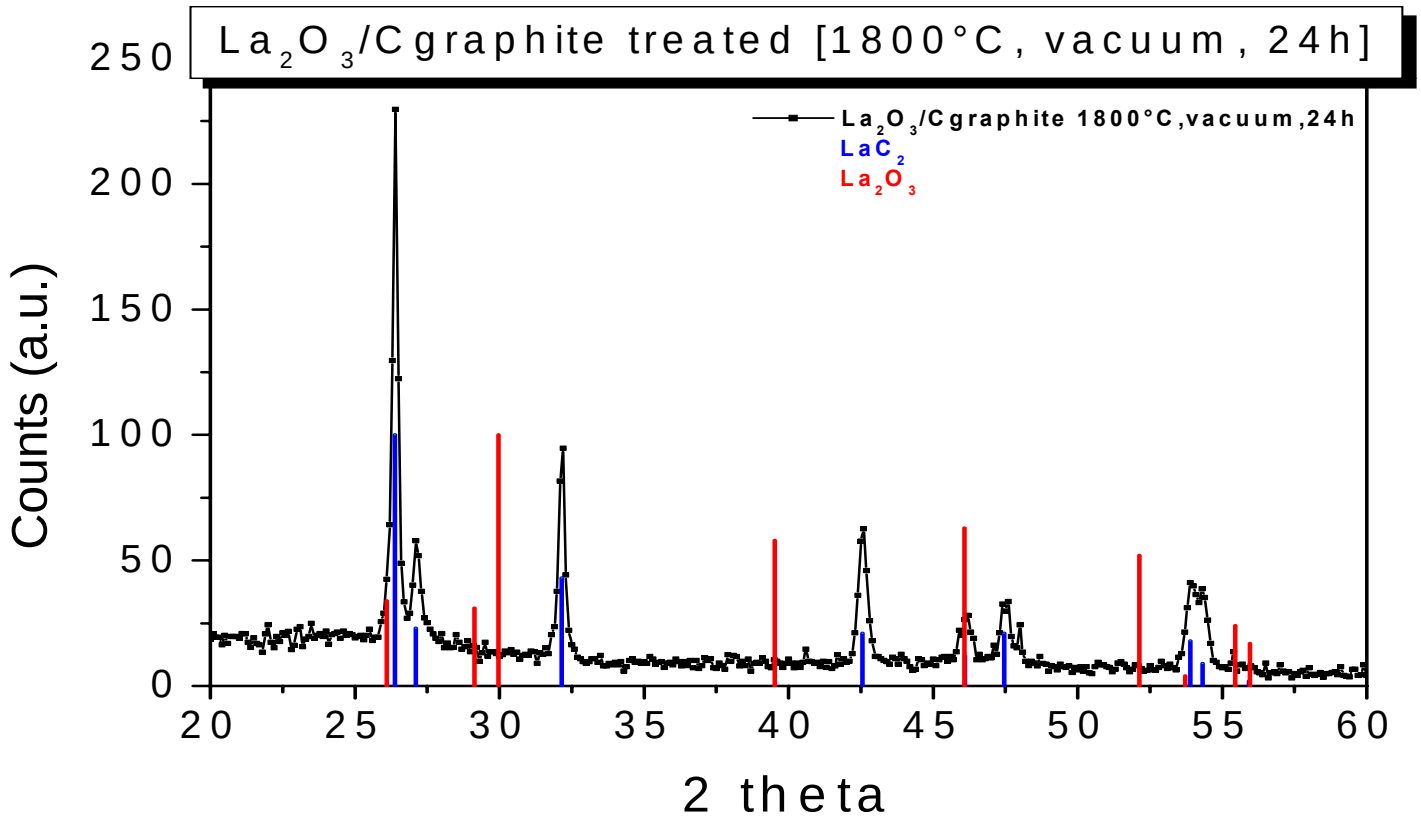
3) THE SAMPLE SHOWS THE PRESENCE OF IMPURITIES LIKE BINDER (PRESENCE OF EXTRANEOUS PEAKS)

Not commonly used techniques: the XRD patterns



1) **THE SAMPLE IS YET MADE UP OF La_2O_3** (HEXANOGAL STRUCTURES)
   CRYSTALLINE GRAINS ARE GROWN (La_2O_3 PEAKS BECOME MORE NARROW AND HIGH)
2) **THE SAMPLE SHOWS YET ANY PRESENCE OF LaC_2** (NO LaC2 PEAKS ARE VISIBLE)
3) **IT IS POSSIBLE TO NOTE THE DECREASE OF THE IMPURITIES QUANTITY** (DECREASE OF EXTRANEOUS PEAKS)

Not commonly used techniques: the XRD patterns



1) THE SAMPLE SHOWS NOW ANY PRESENCE OF La_2O_3 (NO La2O3 PEAKS ARE VISIBLE)

2) **THE SAMPLE IS MADE UP OF LaC_2** (LARGE GRAINS, NARROW AND HIGH PEAKS)

3) THE SAMPLE SHOWS ANY PRESENCE OF IMPURITIES (NO PRESENCE OF EXTRANEOUS PEAKS)

Phase 2: [LaC2 + C] pellets

3) PELLETS TESTING UNDER BEAM

(to be planned)

4) RESULTS

OBTAINED RESULTS

a) COMPLETE CARBURIZED PELLETS HAVE BEEN OBTAINED

b) KNOWLEDGE OF THE CARBURIZATION TEMPERATURE AND DISCRIMINATION BETWEEN CARBURIZATION AND SINTERING PROCESS TEMPERATURE HAS BEEN ACHIEVED

c) VARIOUS SINTERING GRADES OF THE CARBURIZED PELLETS HAVE BEEN OBTAINED

NOT YET OBTAINED IMPORTANT RESULTS

a) MECHANICAL STABILITY OF THE FINAL PELLETS

b) KNOWLEDGE ABOUT HANDLING OF THE FINAL CARBURIZED PELLETS (CHEMICAL REACTIVITY)

Phase 3: UCx pellets

1) PELLETS PRODUCTION:

A PELLET OF URANIUM AND THORIUM OXIDE HAS BEEN PRODUCED

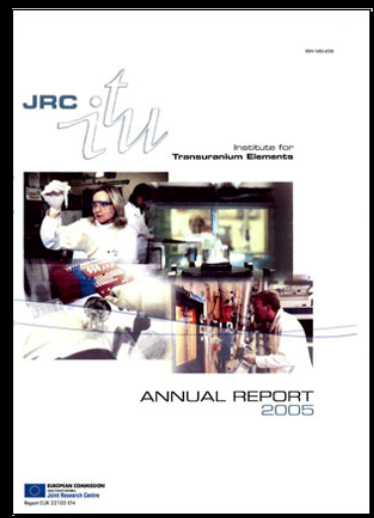
ANY THERMAL TREATMENT HAS BEEN YET PERFORMED (not yet available furnace)

2) PELLETS CHARACTERIZATION

NO CHARACTERIZATION ANALYSES ARE DISPOSABLE AT OUR FACILTIES

IT BECOMES NECESSARY TO RELY ON DEDICATED REASEARCH CENTRES

(IT IS PLANNED FOR TOMORROW A VISIT AT I.T.U. OF KARLSRUHE)



3) PELLETS TESTING UNDER BEAM

(to be planned)

TASK #2

Produced and characterized pellets until summer 06 for SPES DT project

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