Facilitating industrial use of photon, neutron and muon research infrastructure

A point of view from the
personal care, pharmacy, and
specialty chemicals industries
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B. Cabane - List of industrial collaborations (> 1 day/year)

Name	field	paid beamtime	published
UGS	soap		
Rhône-Poulenc	specialty chemicals	SANS, SAXS	films
Rhodia	specialty chemicals	SANS, SAXS	particles
BASF	specialty chemicals		
Lafarge	cement		
Saint Gobain	ceramics	SAXS	particles
Aventis	pharmacy	SANS	vesicles
Sanofi	pharmacy		
Ylipsa	pharmacy		
ADOCIA	pharmacy		
L'OREAL	cosmetics	SANS, SAXS	emulsions
SARP-I	industrial waste		

Average industrial (= paid) use of large instruments:
1 to 3 days /year slowly increasing over 20 years
Total = 30 days of industrial use of D11, ID02 and SWING
recently: ESRF 50 %, SOLEIL 40%, ILL 10 %

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Rem:	The goal of industry is not to use an infrastructure The goal of industrial research is to solve industrial problems in fast, reliable way

Goals of industrial research?

Solve technical problems
Establish structure-property relations
Improve product properties
Establish clear advantage over competition

Are the techniques offered by the large scale infrastructures appropriate for solving industrial problems ?

Personal Care: What are the products?

Aimed at the consumer Applied to the skin= water based, evaporation

Combination of properties: UV protection, hydration, active ingredients
Compositions = water, oil, surfactants, polymers, pigments, actives
Strong demand for new products (20 % of the market)
Must have immediate, visible effets or must feel good (play)
+ longer term effects (?)

Multi component mixtures (> 10 components)
Water based = water has high cohesion, many components do not mix with it
→ emulsions, dispersions, micellar solutions, gels or assemblies of microgel
Aqueous phase contains water, glycols, macromolecules, microgels,
Oil phase contains oils , waxes, pigments, actives
These components do not mix at the molecular scale
→ **segregated at scales = 1-1000 nm**

Need techniques to characterize multicomponent materials
that are segregated at scales = 1-1000 nm
Opportunity for facilities with appropriate instruments
(potential >> 3 days / year/research lab)+

Functions (what does the customer buy?)

1 - Perform tasks that are in conflict with each other
Lipsticks: smooth, easy application, liquid-like surface (shine)
non-transfer, comfort

2 - Bring the active ingredient
to the right place,
at the right time,
in the right form

These properties cannot be achieved with equilibrium states
They can be achieved through a **succession of non-equilibrium states**

In order to improve performance, it is necessary to
characterise and then control these non-equilibrium states
Opportunity for facilities with small angle scattering instruments
(potential >> 3 days / year?)

What difficulties must be overcome?

Most industrial processes take place very far from equilibrium
(why? 1- choice of final state 2- faster kinetics)

START →	RUN →	STOP
Prepare the system In the chosen initial state (composition, T)	Observe the system Through SANS, SAXS Model the structural evolution	Trap the system in final state Or the system stops by itself
Need fast mixing Or T jump	Need high repetition Very large q- range	Does the system have the desired Properties?
Need to understand processes, select one among many	The experiment can be (deceptively) simple	Criterion for success = model the process + predict properties

What difficulties must be overcome?

Multicomponent materials (> 10 components, many of them incompatible)
Segregated over distances = 1-1000 nm
Large instruments such as D11 or ID02 are very good in this range

But: Phase rule → There may be, at equilibrium, **many coexisting phases**
Changes in composition are difficult to interpret (some phases appear, others vanish)

Moreover: must perform tasks that are in conflict with each other
Cannot be achieved with equilibrium states
Can sometimes be achieved with a succession of **non equilibrium states**

Optimize non-eq pathways through a phase diagram where very many phases coexist

Statistical « brute force » or even « clever » optimization methods don't work
(Number of possible compositions >> number of particles in the universe)
Many results obtained by luck or intuitive optimization

→Need to study model systems, then transfer the understanding from model systems to commercial products. Who will do this?

Who will do the work?

Need to define study model systems, then transfer the understanding from model systems to commercial products For a one-day experiment, this involves many days before and many days after the experiment.

Who will do this?

Industrial researchers? (overworked, do not know the techniques offered by ILL and ESRF)

ILL or ESRF staff? (overworked, do not know industrial problems)

Academics? (how do they get involved?)

How can the ILL and ESRF improve the use of large instruments by industry?

In the short term (temporary effects)
1) **Advertise** the potential of the techniques offered by ILL and ESRF
Offer a reduced rate (70 %) for beam-time if a report is written within 3 weeks
Report explains in general terms the aims of the experiments
and the types of results that were obtained. Publish all these reports

2) **Exchange of personnel:** offer to ILL or ESRF staff the possibility
of taking a sabbatical period (6 to 9 months) to take a temporary position in industry
Offer to industrial researchers the possibility of similar position at ILL or ESRF.
Problem: confidentiality!!!

3) Host **conferences** on subjects slightly upstream of the interests of industry

In the long term: (effects after 5 years, long-lasting)
Increase the number of **PhD students** trained by ILL and ESRF
in areas such as materials science, soft matter and physical chemistry
who later may take **positions in industry**
and will then see the potential of techniques offered by ILL and ESRF
for solving industrial research problems

How can the academia and EU improve the use of large instruments by industry?

Solve the interface –manpower problem

4) Create **joint academia – industry research teams**. This has been done already, and it has been successful but without emphasis on the use of large scale infrastructures

5) Create a **network of academic consultants and consulting groups** that
- Are experienced with the use of large scale infrastructures
- Have a record of having successfully solved industrial problems
- Are registered with some certification agency