Research possibilities and activities related to COST Action MP1106 at the **Faculty of Chemical and Process Engineering, WUT**

Research Team name: **AEROMED**
Presenter name: **Tomasz Sosnowski**

Team Presentation – Annual Workshop, COST Action MP1106
Dublin, September 14th, 2012

Team's general info

Research Team Name: **AEROMED**

Number of team members: **10**

Team leader: prof. Tomasz Sosnowski, PhD DSc

- 2 senior scientists (prof. Leon Gradoń, PhD DSc, Arkadiusz Moskal, PhD DSc)
- 5 Ph.D. students
- 2 M.S. student

Expertise:

- aerosol dynamics and interactions with biological interfaces (toxicology & medicine)

- inhalation devices and systems

- CFD modeling of aerosol flow and deposition

Relevance to MP1106

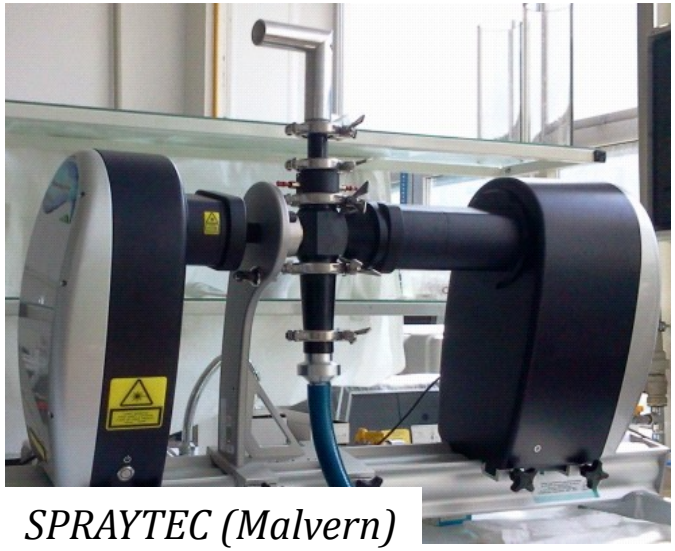
Research interests related to MP1106:

- Interfacial dynamics of the lung surfactant during interaction with inhalable substances (aerosols, gases)
- Particle/droplet interactions with surfaces during inhalation of aerosols (environmental, occupational, medical)
- Microstructures with functional surfaces in application to inhalation therapy (powders, liposomes, cells, etc.)
- Dynamics of inhaled diesel nanoparticles and their interaction with the lung surface
- Numerical modeling (CFD) of flows in dispersed systems

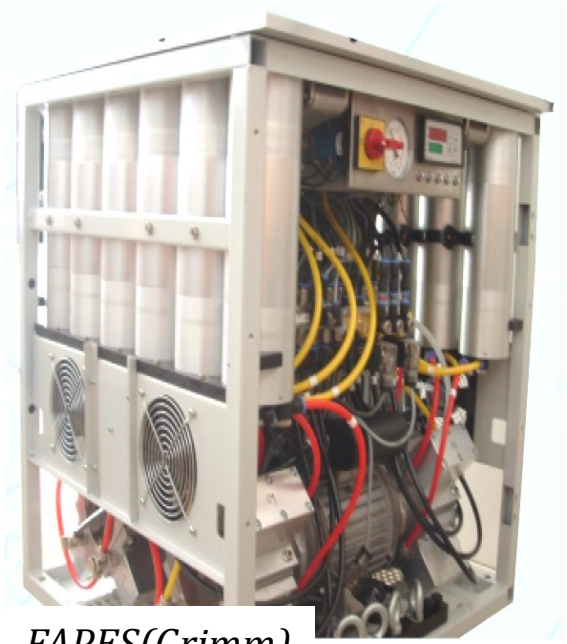
Lab description

Basic equipment:

- Aerosol particle size analyzers and pharmaceutical impactors



SPRAYTEC (Malvern)



FAPES(Grimm)

Andersen Cascade Impactor ACI (Copley)

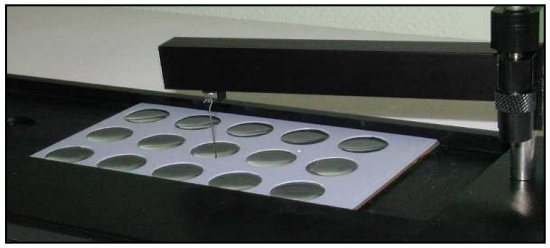
Next Generation Impactor NGI (Copley)

WELAS (Palas)

PDM (Grimm)

Lab description

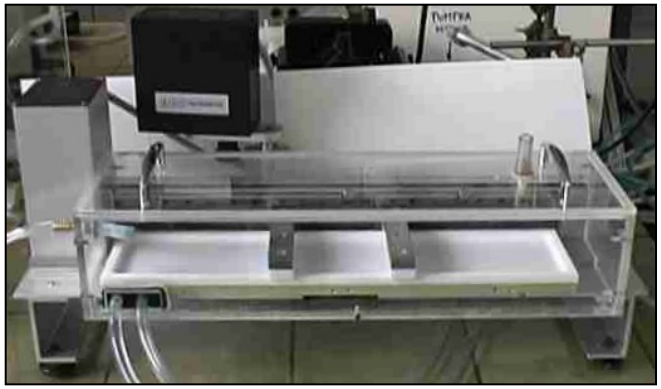
- Surface tensiometers



microPi needle tensiometer (Kibron)

Pulsating bubble tensiometer (Electronetics)

Maximum Bubble Pressure tensiometer (Krüss)



Langmuir film balance (KSV)

Lab description

- Powder particles production and characterization

Laboratory spray drier (Büchi)

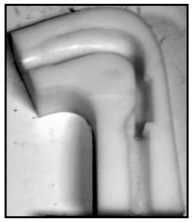
Table-top SEM (Hitachi)

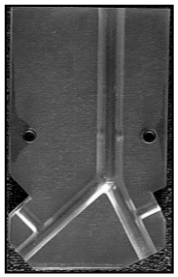
LiQuilaz particle counter (PMS)

Lab description

- Other equipment, e.g., breathing flow simulator, models of the respiratory tract, diesel particles generators, etc.

„Artificial lung”





respiratory tract models (polymeric casts)

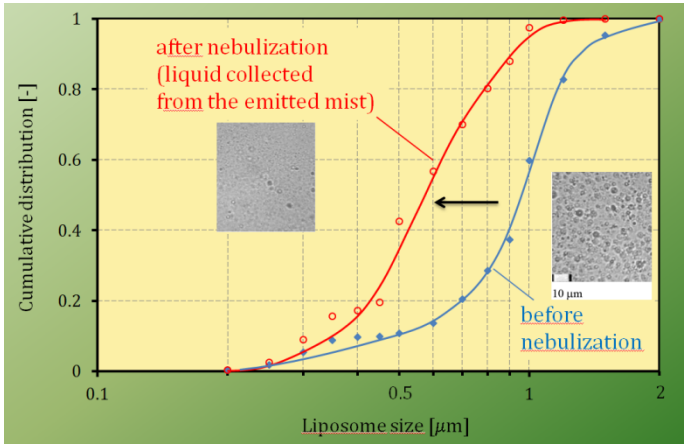
Diesel engine

Spark generator of carbon nanoparticles

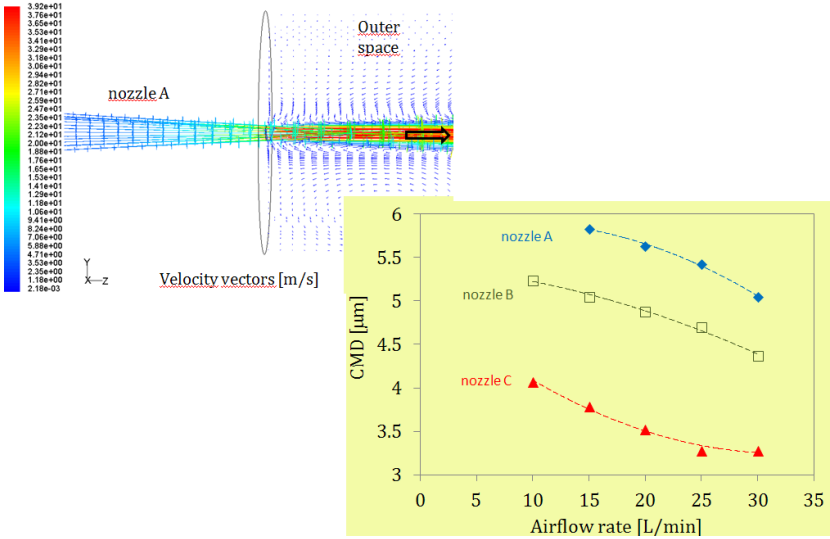
Projects related to MP1106

#1 project :

Title: Aerosol systems for innovative therapuetic applications
Duration: 36 months (until 10.2013)
Funding organization: Ministry of Science and Higher Education
People involved: 6 *(leader: T. Sosnowski)* + MS students
Facilities/equipment: as shown before
Most interesting results:



atomization of liposome colloids

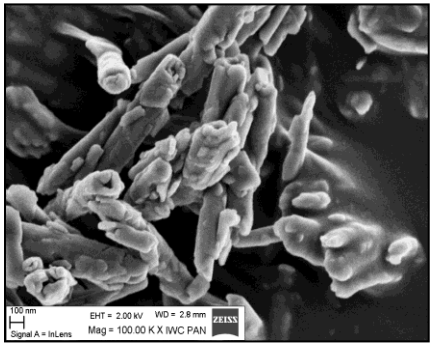


powder aggregates break-up in converged & pulsating flow

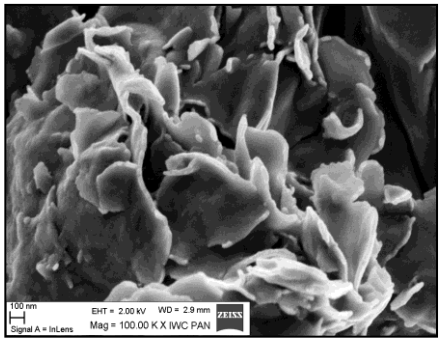
Projects related to MP1106

#2 project :

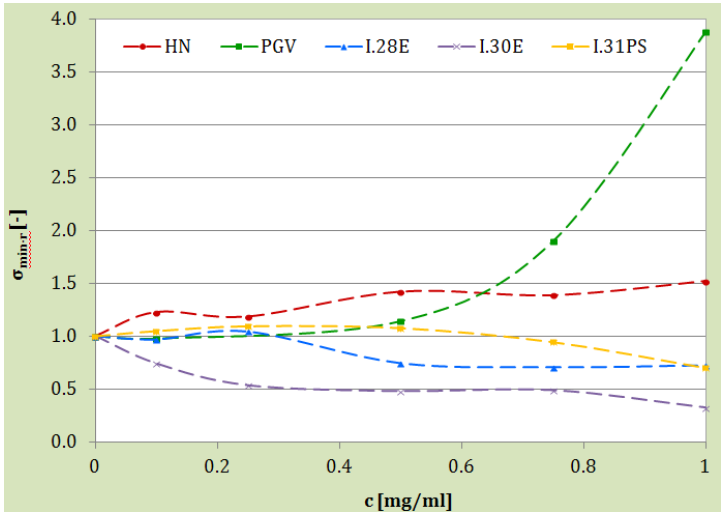
Title: Interaction of clay nanoparticles with lung surfactant - in vitro studies
Duration: 24 months (until 12.2012)
Funding organization: Central Institute for Labour Protection – National Res. Inst.
People involved: 2
Facilities/equipment: as shown before
Most interesting results:



Halloysite nanotubes



Surface-modified montmorillonite nanoplates

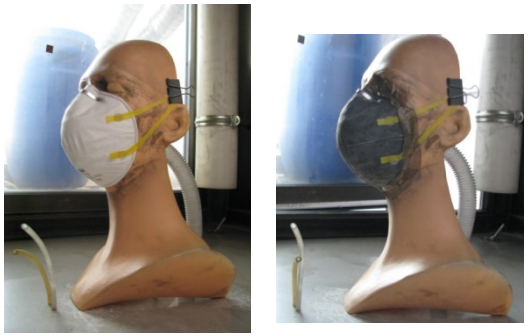


Relative changes of the minimum value of dynamic surface tension (Survanta - oscillating bubble method)

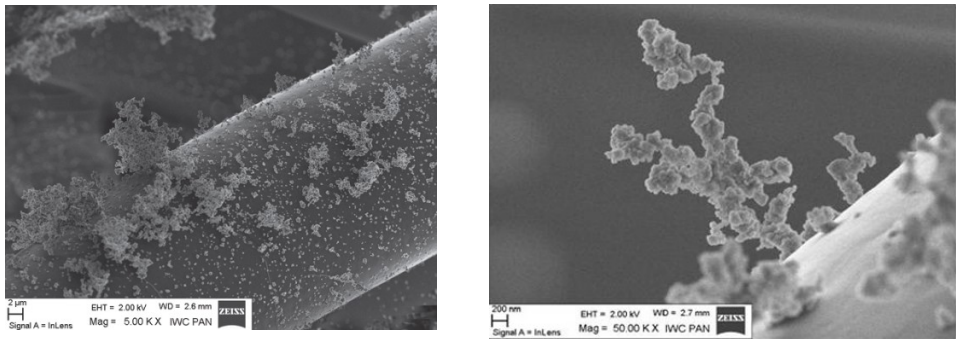
Projects related to MP1106

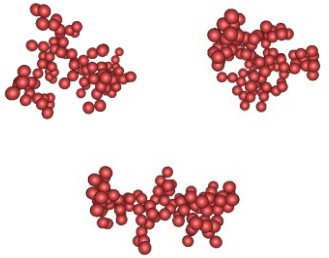
#3 project :

Title: Investigation on toxicity of diesel engine emissions
Duration: 36 months (until 10.2013)
Funding organization: Ministry of Science and Higher Education
People involved: 4 *(leader: A. Moskal)* + MS students
Facilities/equipment: as shown before
Most interesting results:



Penetration of diesel emission through face-masks



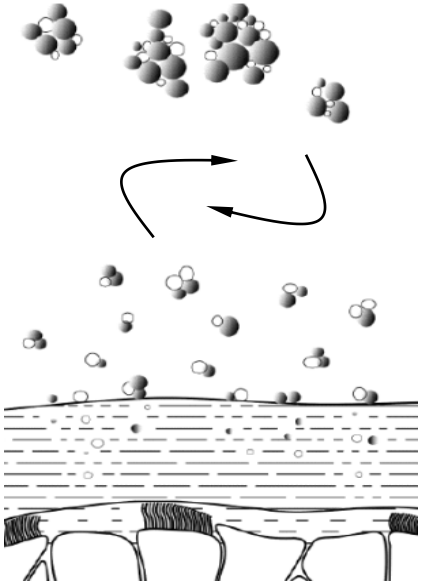


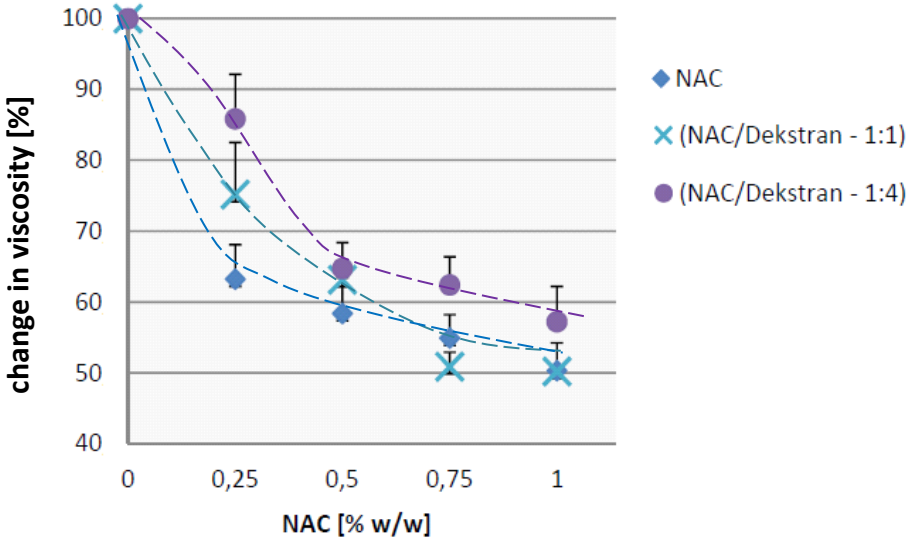
Diesel soot aggregates:
SEM pictures
and numerical models (various D_f)
for CFD simulations

Projects

#4 project :

Title: Manufacturing process and properties of composite carriers for inhalation drugs
Duration: 36 months (finished – May 2012)
Funding organization: Ministry of Science and Higher Education
People involved: 7 *(leader: L. Gradoń)* + MS students
Facilities/equipment: as shown before
Most interesting results:





Publications of the projects

Sosnowski T.R., Koliński M., Gradoń L. - Alteration of surface properties of dipalmitoyl phosphatidylcholine by benzo[a]pyrene: a model of pulmonary effects of diesel exhaust inhalation. *J. Biomed. Nanotechnol*. 8: 818-825 (2012).

Odziomek M., Sosnowski T.R., Gradoń L. - Conception, preparation and properties of functional carrier particles for pulmonary drug delivery. *Int J. Pharmaceutics* 433: 51-59 (2012).

Gac J., Gradoń L. - Analytical investigation and numerical modeling of collisions between a droplet and a fiber. *J. Coll. Interface Sci.* 369: 419-425 (2012).

Kondej D., Sosnowski T.R. - Changes in the activity of the pulmonary surfactant after contact with bentonite nanoclay particles. *Chem. Eng. Transact*. 26: 531-536 (2012).

Sosnowski T.R., Koliński M., Gradoń L. - Interactions of benzo[a]pyrene and diesel exhaust particulate matter with the lung surfactant system. *Ann. Occup. Hyg*. 55: 329–338 (2011).

Kramek-Romanowska K., Odziomek M., Sosnowski T.R., Gradoń L. - Effects of process variables on the properties of spray-dried mannitol and mannitol/disodium cromoglycate powders suitable for drug delivery by inhalation. *Ind. Eng. Chem. Res.* 50: 13922–13931 (2011).

Sosnowski T.R., Gradoń L. - Modification of inhalable powders by pulmonary surfactant components adsorbed on droplets during spray-drying process. *Colloids & Surfaces A: Physicochem. Eng. Aspects* 365, 56-61 (2010).

Kondej D., Sosnowski T.R. - Aerosol generation and identification for model studies of particle-lung interactions. *Int. J. Occup. Safety Ergonomics* 16: 41-48 (2010).

Cooperation with commercial and scientific partners related to MP1106

- MEDBRYT Ltd. (Poland):
  patient-responding computer-controlled nebulizing inhaler

www.medbryt.com.pl

- SECURA NOVA Ltd. (Poland): selected concepts of medical nebulizers

- DISCOVERY LABS Inc. (USA) & Poznan Medical University:
  inhalation systems for intubated infants

- Local and global pharmaceutical companies - e.g. patented active powder inhaler
  (PL: 211358, EU: WO/2008/156381)

Publications resulting from the cooperation with commercial partners

Mazela J., Chmura K., Kulza M., Henderson C., Gregory T.J., Moskal A., Sosnowski T.R., Florek E. - In vitro assessment of a novel aerosol delivery system under simulated neonatal mechanical ventilation conditions. *In: Respiratory Drug Delivery 2012* (Eds.: R.N. Dalby et al,), VCU, Richmond VA, USA, Volume 3, p. 689-694 (2012).

Moskal A., Sosnowski T.R. - Computational fluid dynamics (CFD) and direct visualization studies of aerosol release from two cyclohaler-type dry powder inhalers *J. Drug Del. Sci. Tech*. 22: 161-165 (2012).

Mazela J., Sosnowski T.R., Moskal A., Chmura K., Gregory T.J., Henderson C., Clayton R.G. - Aerosolized albuterol particle size distribution in two aerosol delivery system configurations under neonatal ventilation conditions. *Respiratory Care* 56: 1700 (2011).

Research team from Cracow

K. Malysa with co-workers
in the Jerzy Haber Institute of Catalysis and Surface Chemistry
Polish Academy of Sciences, Krakow, Poland
e-mail: ncmalysa@cyf-kr.edu.pl

Main research areas:

1. bubble motion, kinetics and mechanism of the coalescence at liquid/gas and the three phase contact (TPC) formation liquid/solid interfaces by the colliding bubbles
2. mechanism of bubble bouncing and shape pulsations during collisions with various interfaces, influence of solid hydrophobic/hydrophilic properties and surface roughness on kinetics of the TPC formation
3. effect of the bubble impact velocity and size of the liquid film formed on time of the bubble coalescence at liquid/gas interface and time of the TPC formation at liquid/solid interfaces
4. influence of surfactant adsorption on local and terminal velocities of bubbles
5. dynamics and time-scale of the three phase contact formation (gas-liquid-solid), effect of surfactant on mechanism and time-scale of the TPC formation

K. Malysa with co-workers

For the TPC formation by the colliding bubble a liquid film separating the bubble and the surface needs to rupture and a role of air presence at highly hydrophobic surfaces (nano- and or microbubbles) in kinetics of the film rupture and the TPC formation is studied.
Surface of the rising bubble can be considered and applied as one of the "smart and green interfaces", because velocity of the rising bubble is very sensitive (decreases rapidly) on presence of organic contaminations in water, due to retardation the bubble surface mobility by the dynamic adsorption layer (DAL) formed at the surface. As surface-active substances (SAS) are widely used in many industries and house-holds so they are one of the largest groups of chemicals having negative environmental impact. We have showed that even ppm concentrations of SAS in water can lower velocity of the rising bubble and proposed a simple physicochemical method, called SPMD, for monitoring organic contaminations in waters. High sensitivity, simplicity, no need of a complex sample preparation, no need to use of any expensive (often toxic) analytical reagents are the main advantages of the SPMD method. The method is very swift and sensitive with level of detection below 1 ppm.