PhD in Chemical Engineering

Research Title: Spray freeze-drying as an emerging technology for the preservation of biological macromolecules (LYOSPRAY)

Funded by	Politecnico di Torino (Joint Research Projects with Top Universities)

Supervisor	Roberto Pisano, Politecnico di Torino, roberto.pisano@polito.it Kyuya Nakagawa, Kyoto University, kyuya@kais.kyoto-u.ac.jp

Contact	http://www.disat.polito.it/it/la_ricerca/gruppi_di_ricerca/musychen/molecular_engineering_lab_mole

Context of the research activity	There is a growing interest in continuous manufacturing technologies for the pharmaceutical industry. To provide an example, over the last decade the US pharmaceutical industry has made significant investments in continuous manufacturing (approximately a billion dollars in aggregate) so as to promote the development of new architectures with smaller and more agile facilities. A similar investment is also expected in Europe and Japan within few years, as they host lots of big Pharma and food companies. The present project aims to develop a new technology that enables continuous and much faster production of biological macromolecules. More specifically, the project is focused on the lyophilization process, which is a downstream transformation and is usually the bottleneck of the entire chain of production of biopharmaceuticals. This new process concept combines spray freezing and vacuum drying so as to enable more reliable production through an uninterrupted process.

Objectives	Based on the premises made above, LYOSPRAY aims to develop a new and exciting technology – spray freeze-drying – that enables continuous production of lyophilized microparticles. This technology can be used to stabilize and preserve the biological

	activity of lots of macromolecules that are of interest for both agriculture and pharmaceutical/medical applications. More specifically, LYOSPRAY aims at various objectives: [1] Development of a new process concept for the stabilization of biomolecules through lyophilization. In some cases, manufacturing of lyophilized biological products takes two weeks or a month by batch technology. The present project aims at reducing the processing time to a day or less, combining spray freezing and vacuum drying technology. This combination also enables continuous manufacturing which, by eliminating breaks between steps and hence reducing opportunities for human error, makes the production of biopharmaceuticals, or other biological products, safer and more reliable. [2] Investigation of various technological solutions for the spray freezing. This activity is partially carried out at Kyoto University. [3] Transport through porous media. Mass and momentum transport of rarefied gas through porous media has not yet well investigated, although it is gaining more and more interest in various applications. In the present project, numerical simulations will be carried out to better understand the mechanisms at the basis of vapor transport through porous media, varying shape and size of the pores. [4] Modeling of drying for a packed-bed of frozen particles. Various configurations are investigated for the drying process, involving drying of individual particles or packed-beds of particles. The process efficiency for the various configurations will be evaluated using modeling simulations. [5] Application of the developed technology to a model biological product. [6] Evaluation of market opportunities for the developed technology.

Skills and competencies for the development of the activity	The present research project is a multidisciplinary study; some of the multiple academic disciplines that might potentially be involved are: Chemical Engineering, Pharmaceutical Science, Agriculture Science, and Biology. Experience/interest in Computational Fluid Dynamics, process modeling, process development and design would be an advantage. The PhD candidate will spend the first 18 months at Politecnico di Torino working under the supervision of Prof. Roberto Pisano and the remaining 18 months at Kyoto University under the supervision of Prof. Kyuya Nakagawa