

German-Polish Double Graduation in Materials Science on M.Sc. Level

Authors:

M. Bredol, Fachhochschule Münster, Steinfurt, Germany, bredol@fh-muenster.de
M. Wojcik, AGH, Kraków, Poland, wojmar@uci.agh.edu.pl
H. Altenburg, Fachhochschule Münster, Steinfurt, Germany, h.altenburg@fh-muenster.de
J. Plewa, Fachhochschule Münster, Steinfurt, Germany, plewa@fh-muenster.de
J. Lis, AGH, Kraków, Poland, lis@uci.agh.edu.pl
M. Sopicka-Lizer, Silesian Technical University, Katowice, Poland, lizer@mail.polsl.katowice.pl
L. Blacha, Silesian Technical University, Katowice, Poland, blacha@mail.polsl.katowice.pl

Abstract – AGH University of Science and Technology Cracow, the Silesian Technical University in Gliwice/Katowice, and Fachhochschule Münster - University of Applied Sciences, pursue a bilateral german-polish double graduation scheme in Materials Science. Basis for the common scheme is the course programme in the last four semesters on M.Sc. level. Compulsory for participation in double graduation is a minimum stay of one year abroad and examinations there worth at least 50 out of 120 credit points in this phase. Language of instruction during the stay abroad may be German oder Polish, but in the majority of cases is English. To initialize the programme, the German Academic Exchange Service (DAAD) provided some funding. Students participating can take advantage of EU-Socrates grants. Since the start of the programme in 2002, about 20 students have graduated according to the programme, whereas most participants up to now were students from Poland. About half the students after graduation has entered Ph.D.-programmes in Germany and Poland, the other half has entered the job market in Germany, Poland and the Netherlands. Most of the students participating managed to combine the strengths of their home university and the host university, as well considering the course contents and the style of instruction. Admission to the programme is organized by the home universities in close cooperation with the hosts abroad, thus guaranteeing intense supervision and mentoring. As a result, nearly all students finished the programme and graduated nearly exactly on time. The programme contents stresses the need to reformulate and to adapt existing programmes continuously in response to the development and introduction of novel, modern technologies in transforming industries. All parties have been applying individually for accreditation of their domestic course programmes at their national accreditation bodies; this process has been or will be finished in early 2005. Students then are able to acquire an accredited binational grade without any delay necessary in their course programme.

Index Terms – Double Graduation, Binational Course Programmes, Materials Science, International Exchange

BACKGROUND

Within Europe, most countries prepare the transition from traditional course programmes like the german *Diplom* to new consecutive models on B.Sc. and M.Sc. level. One of the goals of this exercise is the incorporation of more international, especially european components. The european dimension is most important in this respect, in order to lay the foundations for the much desired common European Research Area. Unfortunately, the transition in the various european countries is not always in phase, causing considerable confusion and unnecessary complications in the transitional phase. Even ECTS is not installed everywhere. In order to facilitate the process, integration of course programmes on the european level should take advantage of existing research cooperations and established exchange systems for students and lecturers, e.g. as in the *Erasmus* programme. In this paper, one of these activities in the field of materials science and engineering is described and evaluated. Three universities (one from Germany, two from Poland) are involved. From Germany, Fachhochschule Münster FH-MS (University of Applied Sciences) with its department of Chemical Engineering represents an institution offering course programmes on B.Sc. and M.Sc. level; the department has a rich history of international cooperations in research and teaching. Research activities are found in optical materials and molecular materials science. From Poland, AGH University of Science and Technology Cracow with its faculty of materials science and ceramics offers traditional subjects around mining and metallurgy as well as research in emerging fields like biomaterials. Associated to AGH there is an international school of technology offering technological courses in english language. Third partner, also from Poland, is the Silesian Technical University with its Faculty of Materials Science in Katowice (PolSI). The Faculty has a strong tradition in ceramics, surface coatings and metallurgy. With view on research themes and central activities in teaching, the partners thus offer complementary directions. Therefore, the cooperation aims at combining the individual strengths to a coherent common course programme. Additionally, different teaching approaches should be integrated to provide the best possible synthesis to the students. Fortunately, all partners now offer course programmes on M.Sc. level with similar structure. Therefore, full exchange with subsequent double graduation is possible

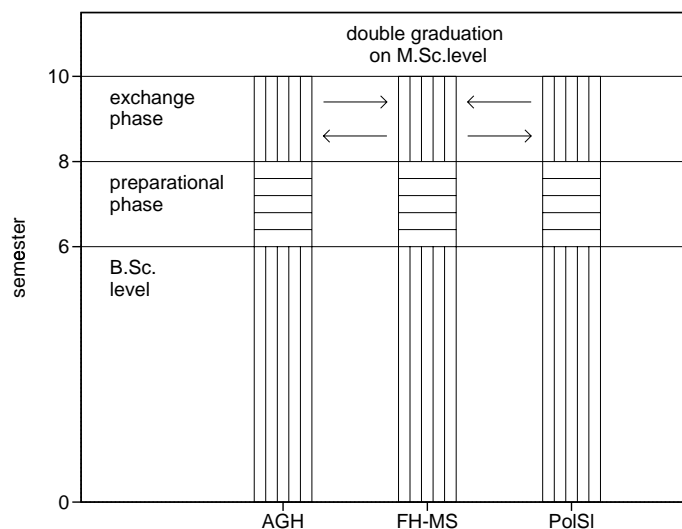


FIGURE 1
General structure of the binational course system

without loss of time in this study phase. All partners use the ECTS system in order to account courses at different locations. One of the most important aspects were and are personal contacts, as well for the development of the course programme, as for the selection and mentoring of suited students. Before the start of the present programme, about 10 years of informal personal exchange (students and lecturers) have been taking place, initiated in the first place by H.Altenburg of FH-MS, and then formalized by the department of chemical engineering of FH-MS.

STRUCTURE OF THE PROGRAMME

The double graduation programme takes advantage of the fact, that the basic course programme at all partners is quite similar. Main difference is the varying amount of classical chemical disciplines, typically providing students from AGH and PoSI with markedly lower theoretical and practical (experimental) skills in chemistry than students from FH-MS. On the other hand, the polish partners are strong in the disciplines of traditional ceramics and metallurgy, which in turn are comparable weak at FH-MS. This background is reflected in the list of electives these students may choose from at the respective partner university, in order to avoid unnecessary frustration of the students. The programme described here thus covers only courses related to materials science (and partially polymer science), but the general structure is open to be filled on top with other disciplines offered at the local universities. The department of Chemical Engineering of FH-MS at present is setting up a similar programme (with respect to organization and guidelines) in chemical engineering, but in this case together with the Technical University of Cracow, since this university is specialized in similar fields as FH-MS in chemical processing.

On the M.Sc.-level, in accordance with ECTS regulations, 120 credit points have to be earned. For double graduation, at least fifty of them have to be harvested abroad, spending at least one year with the partner university. Figure 1 shows the general structure of the exchange programme.

The preparational phase offers special catalogues of electives, but typically is not being used for exchange. The advantage of this model is, that students do not need to pass an extended number of exams in the course of only one year in a foreign language, but rather earn about half of their foreign credit points by a research-oriented master thesis, which may be performed within one of the universities research groups or externally in industry or non-university research institutions (but always under supervision from the host).

The course programme does contain only regular courses about subjects taught regularly at the host university. Therefore, accreditation of the programme can be done independently at all partners. Intensive mentoring helps students to accomplish all requirements without delay. In order not to overstretch the system, typically up to five students are sent from each partner, keeping the total number of foreign students always below ten. Thus, a personal relationship between foreign students and lecturers and organizers is guaranteed. In order to enforce this, most students work on small projects in the research lab during their stay abroad and thus are introduced into the local community.

Table 1 shows for example the electives available for a student from AGH spending the second half of the master programme at FH-MS; the subjects are obviously complementary (technology versus chemistry), and so the students will benefit directly from the combination of these disciplines. A similar scheme is valid for students from PoSI going to FH-MS (see table 2). Students from FH-MS preparing for a stay in Poland would pick subjects from the third column at home and then go for a year

AGH / sem.7	CP's	AGH / sem.8	CP's	FH-MS / sem.9	CP's
Glass technology	15	Physical chemistry of glass and ceramics	12	Chemical Technology of Materials	13
Constructional ceramics	10	Technological Project	6	Advanced Inorganic Chemistry	9
Biomaterials	15	Chemical Technology	6	Materials characterization	6
Technologie of ceramic and glass plants	6	Structures of Solids	6	Macromolecular Chemistry	13
Organization and management	5	Enamels and porcelains	6	Technology of specialty polymers	9
Technical Metals and Polymers	6	Advanced Mathematics	6	Advanced Physical Chemistry	9
Solid state chemistry	12	Informatics	6		
<i>Sum</i>	<i>69</i>	<i>Sum</i>	<i>48</i>	<i>Sum</i>	<i>59</i>

TABLE 1
Typical electives available for AGH–students exchanging with FH-MS

PolSI / sem.7	CP's	PolSI/ sem.8	CP's	FH-MS / sem.9	CP's
Thermal treatment of metals	6	Choice of materials, part I	6	Chemical Technology of Materials	13
Mechanical treatment of metals	6	Choice of materials, part II	10	Advanced Inorganic Chemistry	9
Film technology	6	Quality management	5	Materials characterization	6
Company internship	6	Porous materials	3	Macromolecular Chemistry	13
Powder metallurgy	5	Corrosion of ceramics	3	Technology of specialty polymers	9
Theory of composite manufacture	6	Unit operations in ceramics	6	Advanced Physical Chemistry	9
Solid state chemistry	3	Ceramic technology and recycling	3		
Surface treatment	6	Mechanics of composites	6		
Composite development	6	Frictional composites	6		
<i>Sum</i>	<i>50</i>	<i>Sum</i>	<i>45</i>	<i>Sum</i>	<i>59</i>

TABLE 2
Typical electives available for PolSI–students exchanging with FH-MS

to the Polish partner universities.

Students may focus their interests further by proper choice of their subject for the master thesis. The subjects chosen so far range from investigations into biomaterials over preparation of catalytic supports to industrial problems around anti-corrosive coatings on metals. Due to the personal mentoring system established, choice of these subjects as well as of electives can be organized according to personal student's needs. This is reflected in the fact, that nearly all students finished the binational course programm within the time frame envisaged and therefore did not accumulate any delay with their course programme.

The language of instruction in most cases is English for practical reasons. Neither German nor Polish find sufficient acceptance in the engineering community, so all courses are typically taught in English, if foreign students are joining in. However, students are very much encouraged to learn as much as possible of the local language.

CAREER PATHS

The level *Master-of-Science* qualifies successful students for leading positions in industry, for national or international Ph.D.-posts, for independent research in research organizations like e.g. *Max-Planck-Institutes*, *Academies of Science-Institutes*, university groups or industrial research organizations. First experience with about 20 students passing the programme shows, that about one half of the students has been taking up Ph.D. positions in Germany or Poland, and about one half has opted to take up industrial posts in Poland, Germany and the Netherlands. Especially on the very tight Polish job market, participants in the binational programme had remarkable success. On the scientific side, several participants have won prestigious awards (Rector

prize of FH-MS, Distinction award of AGH, DAAD award) and grants (International graduate school in chemistry Münster, *Marie-Curie*-grants), testifying the high academic standards of the programme and its participants.

SPECIAL REQUIREMENTS FOR MATERIALS SCIENCE PROGRAMMES

Materials science is a trans-disciplinary field; chemistry as well as physics, mathematics, mechanical and electrical engineering are classical disciplines involved in materials science and engineering. This situation requires a special approach from all disciplines involved, but especially from mathematics. Since the combined factual basis of the underlying disciplines is by far too large, a coherent subset has to be taught in the course programmes, without compromising the scientific integrity. Thus, concepts should be taught on all levels rather than singular phenomena. This background requires to overcome traditional subjects in materials science; mathematics as the intellectual base needs to be strengthened in the proper way. Since a lot of phenomena in materials are related to kinetic effects, proper sets of differential equations describing rates are most important. Therefore, solving such systems by (preferably) analytical or numerical methods is a prerequisite for quantitative description of phenomena. Room for engineering mathematics has to be claimed by omission of elements of pure mathematics that still are found abundantly in some courses for materials engineers. Another emerging field in materials science is modelling, stretching from quantum chemical methods to molecular dynamics, simulating large systems. A basic understanding of the mathematics behind is very important when using such methods; on the other hand direct coding of algorithms is not necessary since various commercial and free computational packages are available.

FORMAL ASPECTS OF COOPERATION

The participating universities have started their cooperation by signing contracts regulating students exchange and bilateral recognition of course results. Tuition fees were explicitly excluded for participating students, and acceptance of *Socrates* students was granted. This started first between AGH and FH-MS and led in the first place to exchange of students for internships and participation in research activities; development of a binational integrated course programme was started in this phase. Since the polish partners at the moment do not offer a formal B.Sc. degree, the bilateral contracts regulate, that successful fulfillment of all obligations up to the sixth semester by polish students at their home university qualifies them formally for participation. This has to be certified by the local dean. German students need to carry at least a B.Sc. degree, so their formal qualification had not to be regulated explicitly. After successful implementation and start-up a similar contract was signed between the Faculty of Chemical Engineering at FH-MS and the Faculty of Materials Science and Engineering at Silesian Technical University in Gliwice (PolSI), with the set-up of an integrated course programme directly in mind. The local coordinator in Münster (Dr. Julian Plewa) was formerly a lecturer at PolSI in the late eighties and at the same time holds close personal relationships to personnel at AGH. Personal trust is a very important component of the system, because in this way selection of suited students is being managed always locally and thus keeps the administrative burden bearable. The final examinations are always performed under the supervision of representatives from all partners involved in the exchange. It should be stressed that all students being exchanged so far were receiving *Socrates/Erasmus* grants. The relevant contracts have been renewed now already several times. Students exchange was complemented by intensive exchange of lecturers, since fortunately professors field and activities are complementary; where professors from Steinfurt lectured about functional materials and basic colloid science, colleagues from Cracow and Katowice gave regular lectures on properties of e.g. glass and ceramics. This aspect prepares engagement in research collaboration; first steps were taken by organization and participation in multilateral and bilateral scientific events, like participation in a Copernicus project, in Ceramic Seminars organized in Steinfurt (2001-2002), the Conference of Polish Ceramic Society (Zakopane 2003, Kraków 2004) or the International workshop on Thermoelectrics (Kraków 2004).

After fulfilling all requirements and passing all necessary examinations, the students are provided with at least three documents: a diploma about their academic grade of *Master of Science*, issued in two versions by the cooperating universities (polish and german) according to the respective national regulations. These documents are accompanied by a transcript of records (german part included on the diploma, polish part documented in an index booklet) and a diploma supplement, describing structure and status of the programme.

Meanwhile, all three partners have been going successfully through the process of accreditation of their course programmes by national accreditation boards. Now partners try to have the integrated programme also accredited internationally. This process has a pioneering character and needs to be brought to a successful end still, since there are no explicit european or german-polish regulations for such a case.

FUNDING

A binational programme with partners at a distance of about 800 km's generates additional costs for lecturer exchange, bilingual documents, additional services in department administration, preparation of lab exercises and language training. Fortunately, a

grant of the German Academic Exchange Service (DAAD) partially covers such extra cost in the first 5 years of the programme. Additionally, the *Land Nordrhein-Westfalen* has provided additional funding for bilingual elements. In bilateral agreements, the partners guarantee, that there will be no tuition fees, thus avoiding additional costs for students. But, due to the still markedly different levels of living costs, staying and living in Germany especially for Polish students is very expensive. In order to help with this situation, most Polish students are contracted during their stay in Germany as lab helpers, earning this way about half the money a student in Germany typically needs for subsistence. On top, there is nearly always a Socrates grant, so that students typically have enough money to survive for at least one semester in Germany. If the master thesis is prepared externally (industry or research organisations), students typically are supported in this phase from research funds. Polish as well as German students are enrolled regularly at the host university during their stay abroad, so they enjoy full social benefits like access to rooms in dormitories, cheap meals, reduced or free local transport tickets etc.

ACKNOWLEDGEMENTS

The development and installation of the binational programme described was only possible through the continuous support of the faculties and departments involved. All sides had a huge interest establishing a demanding, but workable course programme. Rectors and vice rectors of all partner universities were involved in an early stage and gave not only support, but encouragement to proceed. Without the EU-Socrates programme it would not have been possible to attract students, so thanks are due to the European Commission. Grants provided by *DAAD* and *Land Nordrhein-Westfalen* were most welcome.