INDUSTRIAL PRODUCT AND PROCESS ENGINEERING

PhD Coordinator- 40° ciclo

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The PhD course requires students to develop their own research project in one of the four curricula :

1. **Materials and Structures Engineering**
2. **Chemical Engineering**
3. **Production Technologies and Systems**
4. **Designing Sustainable and Safe Products and Processes**
   Excellence Department

or has interdisciplinary characteristics between these curricula.

- The research project is chosen from among those proposed by the DICMaPI professors.

- The PhDstudent will be supervised by a tutor, the teacher who proposed the research activities, and possibly by a Scientific Committee made up of national or international experts.

XL cycle PhD students

N.	TIPOLOGIA FINANZIAMENTO	NOME ENTE/IMPRESA	ASSEGNATARI	TEMATICA	TUTOR
1	DM 630/2024	CIRA SCpA	RUSSO MARCO	Tecnologie additive metalliche per il settore aerospaziale	Prof. Antonio Langella
2	ATENEO		ENICCHIARO DOMENICO	Ottimizzazione del rischio e della sicurezza delle batterie a base di Litio	Prof.ssa Almerinda Di Benedetto
3	ATENEO		DI FRANCO FABRIZIO	Stoccaggio di idrogeno in soluzioni acquose di formiati/bicarbonati	Prof. Danilo Russo
4	DM 630/2024	SABIC Petrochemicals B.V.	FERRANTI MARCELLO	Ruolo delle ramificazioni molecolari sulla processabilità e le prestazioni di materiali poliolefinici in ottica di economia circolare	Prof. Salvatore Costanzo
5	DM 630/2024	Fater	VALLEFUOCO FEDERICA	Creazione di versioni virtuali di impianti industriali da utilizzare come strumento di Modelling&Simulation	Prof. Pier Luca Maffettone
6	ATENEO		GARGIULO PASQUALE	Materiali innovativi per batterie metallo-aria ecosostenibili	Prof. Aniello Costantini
7	DM 630/2024	CIRA SCpA	CALDORE GIANMARCO	Sviluppo di coating polimerici nanostrutturati a basso impatto ambientale per applicazioni aerospaziali	Prof. Giovanni Filippone
8	DM 630/2024	Olitech	ACIERNO STEFANO GIOVANNI	Produzione di gas naturale sintetico (SNG) in reattori avanzati per la conversione di CO2 con idrogeno rinnovabile	Prof. Amedeo Lancia - Prof. Alessandro Erto
9	ATENEO		PEDATO AGNESE	Biomeccanica di sferoidi tumorali	Prof. Sergio Caserta
10		ASI	FOGLIA IGINO	Elettroidrodinamica di fluidi biologici complessi per la detection di biomarcatori	Prof. Gaetano D'Avino
11	DM 630/2024	CIRA SCpA	GALLO ANTONIO	Modellazione del comportamento a danneggiamento, fatica e frattura di materiali per applicazioni in ambienti non convenzionali	Prof. Enrico Armentani - Prof. Michele Perrella
12	DIPARTIMENTO DI ECCELLENZA		RICCARDI PAOLO	Modelli multiscala per lo studio del processo "Grafting-to" per la produzione di "Brush" polimeriche funzionalizzate	Prof. Giuseppe Mensitieri - Prof. Giuseppe Milano
13	ATENEO		DESIDERIO FULVIA	Rivestimenti di leghe di metalli leggeri mediante ossidazione elettrolitica al plasma (PEO)	Prof. Tullio Monetta
14	DM 630/2024	I.T.P. Innovation & Technology Provider S.r.l.	MAURIELLO FRANCESCA	Recupero biotecnologico di scarti di caffè in polvere (SCG)	Prof. Roberto Nigro
15	POSTO SENZA BORSA		SERRECCHIA SIMONE	Progettazione di nanomateriali intelligenti da bioscarti per l'agricoltura sostenibile	Prof.ssa Giuseppina Luciani
16	ATENEO		CERULO ANGELA	Formulazione e design di fibre ottiche basate su idrogeli biocompatibili per l'ingegneria biomedica	Prof.ssa Rossana Pasquino
17	POSTO SENZA BORSA		RIZZO MORENO	Sviluppo di materiali adsorbenti avanzati per la rimozione di inquinanti recalcitranti da acque reflue	Prof. Domenico Pirozzi - Prof.ssa Filomena Sannino
18	POSTO SENZA BORSA		MISHQAT AROOJ-UI	Riduzione di Ilmenite in letto fluidizzato per la produzione di ossigeno gassoso in ambiente lunare	Prof. Fabrizio Scala
19		ASI	BARTEK JANOS	Tecnologie opto-microfluidiche label-free per diagnosi precoci	Prof. Massimiliano M. Villone
20	Eni Award "Young Talents from Africa"		CHUI PETRA KIENNYIY	Pirolisi di plastiche per il recupero di materie prime secondarie	Prof. Piero Salatino

PHD

- The PhD course normally lasts three years. It requires attendance in DICMaPI laboratories or in Research Institutions funding the PhD scholarships.

- The PhD student has to carry out a research period abroad of at least three months, preferentially in the second year (if it's not otherwise regulated by grant funding institution).

- The foreign research institute and the abroad period is normally already defined when the grant is activated. Any change must be communicated to the coordinator and the administrative secretary, who will ask to UDABS to activate the change procedure (on average a two-month wait as the change must be authorised by the MUR).

PHD

The abroad period is regulated by special legislation that provides for:

- Activation of insurance policy and 50% grant increase;

- The student, in agreement with the supervisor, who must be copied on all communications, requests an invitation letter from the host professor, which must specify the start and end dates of the activity and the research activity that the PhD student will carry out at the host institution;

- The PhD student will then inform the Coordinator of intention to go abroad for a period of study/research;

PHD

- If the number of months abroad is less than 6 months, the coordinator will authorise and decide on additional financial support from DICMaPI or the supervisor, if available. For a period of more than 6 months, the approval of the PhD board is required.

- The abroad period activation can only be started at the end of this procedure..

TRAINING ACTIVITIES

The training programme consists of the set of research and study activities that PhD students must complete to obtain the final PhD degree.

The detailed training programme for each doctoral cycle is approved by the PhD board.

The training programme (180 credits) synergistically combines different subjects, mainly engineering subjects, but also focusing on basic mathematical sciences aspects.

TRAINIG ACTIVITIES

PhD Credits (180 CFU):

- 33 CFU for courses with a final examination certified by PhD course teacher or for Master's degrees differents than there degree, Doctoral Schools.
- 3 CFU for seminar activities without a final examination, workshops, conferences.
- 144 CFU for research activities.

Ore	CFU
16	3
20	4
30	6

Insegnamenti Corsi LM

Ore	CFU LM	CFU riconosciuti
48	6	3
72	9	6
96	12	9

TRAINIG ACTIVITIES

In the case of educational gaps, the CFUs for teaching activities are supplemented by a further 12 CFUs for teaching at Masters level. In this case, the number of research CFUs is reduced to 132.

Ancillary or supplementary teaching activities - thesis supervision, tutorials, exams - may be assigned to the doctoral student up to a maximum of 40 hours per year.

TRAINIG ACTIVITIES

The catalogue of offered training activities includes courses activated during the three years of the doctoral programme and courses organised in collaboration with other university PhD programmes.

Informations on active courses are available on https://www.dicmapi.unina.it/dottorato.

However, the choice of Phd students is not limited to catalogue mentioned above. With the prior coordinator's approval, students may attend courses offered by other universities and research organisations. Participation in national and international PhD schools is considered an educational activity. A certified final examination for the courses attended is always required. Participation in congresses and plenary lectures are not considered as training activities to be included in the calculation of the 36 CFU.

TRAINING ACTIVITIES

Compulsory training activities relating to:

- **Laboratory safety and PPE**
- **Knowledge and use of a foreign language in science**
- **the use of IT tools**
- **Exploitation of research results and intellectual property**

To enter in research laboratories, students must be registered on the DICMaPI list of equivalent workers (compliance with health surveillance health surveillance and training)

PHD

- At the end of the PhD cycle, the thesis, with the report on the activities carried out during the PhD programme and any publications, will be examined by at least two referees, not members of the institution awarding PhD and who have a high level of experience, at least one of whom must be a university teacher.
- Referees, from foreign or international institutions, express an analytical evaluation for the admission to final discussion or postponement final exam for a maximum of six months if they consider that substantial additions or corrections are necessary.

PHD

- If there are demonstrable reasons why PhD thesis cannot be submitted on time, the Teaching Committee may, at the PhD candidate's request at least one month before the end of the course, grant an extension of a maximum of twelve months (6 or 12 months) without further financial contribution.

- An extension of PhD course for a period not longer then twelve months (6 or 12 months) may also be decided by Teaching board for justified scientific needs, ensuring in this case the corresponding extension of scholarship with funds from the university budget.

SCHOLARSHIP PAYMENT

The PhD grant is paid monthly. The grant is awarded on the basis of a bimonthly attendance certificate signed by PhD coordinator. The doctoral candidate has to work in DICMaPI, unless there are justified and documented reasons for absence.

The supervisor(s) must ensure PhD student’s presence and activity.

The doctoral fellowship cannot be combined with any other type of fellowship, with the exception of grant paid by national or international institutions that are useful for supplementing PhD abroad training activities.

ADMISSION TO THE FOLLOWING YEAR

- At the end of each year (31 October), PhD students must produce a detailed report of his/her activities.
- The Teachers Board will decide on the candidate's admission to the following year or will propose to the Rector that student can be excluded from the programme.
- The student will prepare an activity sheet which will be published on the PhD website (the sheet will be updated at the end of each year).

ACTIVITY SHEET

FLAME-FORMED CARBON NANOPARTICLES: SYNTHESIS AND CHARACTERIZATION

Francesca Picca – Advisor: Prof. Andrea D'Anna

Curriculum: Ingegneria Chimica

Nanoparticles and nanostructured materials characterize an increasing research area, gaining strong attention from the scientific community in several fields. During the last decades, many and extraordinary technological advances have been obtained by nano-materials due to their physicochemical properties. In nature, at micro- and nano-scale, materials have existed for a long time before, but it is only through the advent of the technological era, and consequently, the development of nanotechnology, that they have come to the fore.

There are several forms of nanoparticles: metal-based, organic-based or organic/inorganic combination and carbon-based ones.

Carbon nanoparticles are the most widely studied as carbon is suitable and available raw material. Except for hydrogen, carbon has the most significant number of known compounds and is present on the planet in various forms: from carbon to light and heavy hydrocarbons. Carbon-based nanoparticles have shown a wide variety of structural arrangements that make them a great advantage as they are suitable for various purposes.

Several techniques exist to cope with the production of the nano-size materials in both liquid and gas phase; examples are arc-discharge, laser ablation, chemical vapour deposition. The more the process allows to have a production (functional to specific final characteristics of the material) on a large scale and in an economical way, the more it is taken into consideration and studied.

Among the various techniques, the use of flame and, therefore, combustion technology is increasingly taken into consideration. Traditionally, combustion is associated with the study of particulate matter and undesired products released into the atmosphere daily to understand the onset of their formation and reduce, if not abate, their emissions. Nevertheless, on the other hand, flame-formed carbon nanoparticles have been the subject of increasing interest in recent decades as a new procedure for synthesizing engineered nanoparticles.

In order to obtain flame nanoparticles with desired characteristics and with the highest yield, it is necessary to have an in-depth knowledge of their formation process through the reaction system, the flame. It is necessary to delve into the chemical and physical details of the various steps of the mechanism that lead to the final product; pay attention to the inherent characteristics of the particles, such as size distribution, chemical composition, and physical characteristics.5

Moreover, depending on the final product to be obtained, flames can be modulated and varied in parameters such as temperature, residence time, mixing effect, and the fuel or additive structure.

This PhD thesis focuses on studying and characterizing the carbon nanoparticles synthesized in the well-controlled combustion conditions of premixed fuel-rich flame, using a lab-scale reactor constituted by flat laminar ethylene/air premixed flame. The primary purpose of this activity has been to perform an experimental study on flame-formed carbon nanoparticles, with great attention on the still too unclear step of particle formation in flame, i.e. the nucleation.

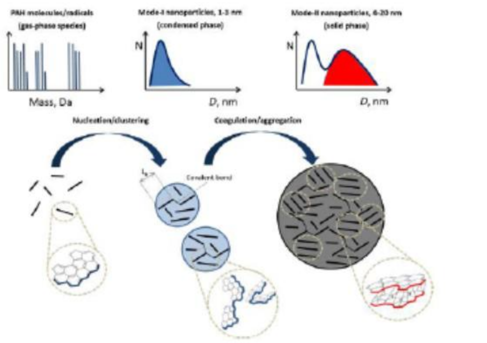
The first year of the PhD was primarily centred on the study and preliminary characterization of physicochemical evolution of flame-formed carbon nanoparticles. In order to produce different sizes of particles, carbon nanoparticles were collected at different distances from the flame front, i.e., the residence time in the flame was changed.

Then, various techniques were used to characterize the produced particles.

One of the first investigations was performed in the flame by the on-line differential mobility analyzer to study the particle size distribution. Subsequently, the analytical tools continued with ex-situ techniques such as Raman spectroscopy and Electron Paramagnetic Resonance, the former for chemical and structural information on particles modification and the latter to reveal and confirm the presence of radicals and to identify them.

In this thesis, great attention was laid on the presence and role of radical species, above all, in the determining step of nucleation. For this reason, the research continued in the second year with a more detailed analysis of radical formation in the flame products mechanism and a more specific structural characterization of carbon nanoparticles. Indeed, a density functional theory study investigated some aspects related to the behaviour of radical molecules in flame in terms of dimerization and formation of cluster structures. Notably, the study was helpful in the differentiation between σ- and π-radicals. Following the theoretical evaluation of the radical molecules, the question was raised about how such radicals could form, i.e., whether specific structural elements could facilitate their formation and, consequently, direct carbon particles' formation through a specific mechanism. This type of structural investigation was performed through the Proton Nuclear Resonance Spectroscopy ,1H-NMR; for the first time used in a system such as the one studied in this thesis work.

Then, in the third and final year of this PhD research work, a comparative physicochemical evolution study in an aromatic fuel environment has been performed. The addition of an aromatic dopant, such as benzene, leads to some change in the flame and the particle formation in terms of particles size distribution, Raman features, and especially radical production, allowing to face up the same questions in such environment and to investigate the effect of aromatic fuel on the nature and the role of radicals in particle nucleation and growth.



References:

Picca, F., De Falco, G., Commodo, M., Vitiello, G., D'Errico, G., Minutolo, P., D'Anna, A. "Characteristics of flame-nucleated carbonaceous nanoparticles" (2019) Chemical Engineering Transactions, 73, pp. 61-66. DOI: 10.3303/CET1973011

Vitiello, G., De Falco, G., Picca, F., Commodo, M., D'Errico, G., Minutolo, P., D'Anna, A. "Role of radicals in carbon clustering and soot inception: A combined EPR and Raman spectroscopic study" (2019) Combustion and Flame, 205, pp. 286-294.DOI: 10.1016/j.combustflame.2019.04.028

Sabbah, H., Commodo, M., Picca, F., De Falco, G., Minutolo, P., D'Anna, A., Joblin, C. "Molecular content of nascent soot: Family characterization using two-step laser desorption laser ionization mass spectrometry" (2020) Proceedings of the Combustion Institute. DOI: 10.1016/j.proci.2020.09.022

Commodo, M., Picca, F., Vitiello, G., De Falco, G., Minutolo, P., D'Anna, A. "Radicals in nascent soot from laminar premixed ethylene and ehtylene-benzene flames by electron paramagnetic resonance spectroscopy" (2020) Proceedings of the Combustion Institute. DOI: 10.1016/j.proci.2020.08.024

De Falco, G., Picca, F., Commodo, M., Minutolo, P. "Probing soot structure and electronic properties by optical spectroscopy"(2020) Fuel, 259. DOI: 10.1016/j.fuel.2019.116244

Gentile, F.S., Picca, F., De Falco, G., Commodo, M., Minutolo, P., Causà, M., D'Anna, A. "Soot inception: A DFT study of σ and π dimerization of resonantly stabilized aromatic radicals"(2020) Fuel, 279. DOI: 10.1016/j.fuel.2020.118491

Francesca Picca, PhD, April 2021

FINAL EXAMINATION

- Final examination admission is decided by Teachers Board after presentation and discussion of the activities (by 31 October).
- The student must have published at least one paper in a peer-reviewed journal and presented the activities as a speaker at an international congress.
- The draft thesis will then be sent to two external referees for final approval.
- The thesis is revised according to the reviewers' comments and then deposited in the Doctoral Thesis Archive (FEDOA).
- The coordinator must validate the thesis before it is discussed.

DOCTOR EUROPAEUS

Students who have spent at least three months in a European country other then Italy can apply for the additional Doctor Europaeus certification.

Theachers Board may propose Doctor Europaeus certification, which attests that the candidate has carried out a research activity in a European country other than Italy for at least three months during the PhD course, following the good opinion of two referees belonging to university institutions in two European countries other than Italy;

The Commission must include one member from an academic institution in a European country other than Italy.

ABROAD PERIOD AND MISSIONS

Mission requests must:

- be complete (place-date-time),
- contain «PhD Fund xx° Cycle» when using your own PHD fund be signed by your supervisor as responsible for the fund
- be sent to MISSIONI.DICMAPI@UNINA.IT (in pdf), with a copy to your supervisor be relevant to your PhD project.

In case of mission request authorization not on your own PhD fund, the document has been sign your own tutor and fund responsable, both in copy, when sending the request.

ABROAD PERIOD AND MISSIONS

Requests for missions for PhD studies and research must be supported by an invitation letter from the host institution and the approval of PhD Coordinator.

Once the authorisation has been received from the Coordinator or the Teaching Board, the PhD student must apply to the Director for mission's authorisation, according to the procedures described above;

Then PhD student must send the invitation letter, a short abstract of the activities to be carried out abroad and the authorisation from the coordinator to Dr Antonia Collini, who will proceed with period abroad opening.

ABROAD PERIOD AND MISSIONS

Upon return, PhD student must send the Transcript of Records to Dr Antonia Collini, in which the tutor of the host institution certifies the end of planned research activities;

Only then will the UDBS pay the 50% grant increase.

Only recipients of PhD scholarship are eligible for the 50% increase; those without a scholarship may use the annual budget for research activities, but cannot apply for the 50% scholarship increase.

Refunds

Claims for reimbursement must be:

- supported by a list of documents
- Dated on the submission date of refund request
- Delivered with all original paper receipts, digital receipts (MISSIONI.DICMAPI@UNINA.IT)
- (for paper receipts), stapled on A4 sheets and numbered according to the list of receipts.

The receipts must show the currency used; in the case of foreign currency and euro conversions, the two amounts must be shown on the same line.

MISSION ANTCIPATION

Requests for mission anticipation (previously approved by Teachers Board) must be sent to:

- MISSIONI.DICMAPI@UNINA.IT

- Mission refunds will be made within 30 days by receipts list delivery of supporting documents.

N.B. All documents relating to mission requests, advances and reimbursements must be in pdf format; other formats will not be accepted.

PURCHASE OF EQUIPMENT FOR DOCTORAL ACTIVITIES

Requests for PhD fund purchases must be:

- sent to antonio.vecchiarini@unina.it, with a copy to their Tutor and the purchase request form -RdA- (in pdf) signed by the applicant and his/her Tutor

- supported by two quotes obtained from companies on MEPA (the costs of the cheapest will be indicated on the RFP)
- made before 31 July of the final year of the PhD.

N.B. It is not possible to purchase inventory goods.