Torres-Herrador **Francisco**

PhD · Aeropace Engineering

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Education

Vrije Universiteit Brussel & Ghent Univeristy — *Belgium*

PhD — *Sept. 2017 - Mar. 2022*

"Thermal response of carbon composites submitted to high temperatures: application to atmospheric entry." Double PhD degree program between the Vrije Universiteit Brussel (Prof. Julien Blondeau) the von Karman Institute for Fluid Dynamics (Prof. Thierry Magin) and Ghent University (Prof. Kevin Van Geem).

- Study the thermal degradation of thermal protection materials and space debris made of carbon composites such as carbon/phenolic or carbon/epoxy systems.
- Understand changes in material properties when submitted to high temperatures.
- Develop methodologies for characterization of material properties.
- Graduated with greatest distinction

von Karman Institute for Fluid Dynamics — *Rhode Saint Genese, Belgium*

Research Master in Fluid Dynamics — *Sept. 2016 - June 2017*

- Specialization in High speed flows and thermal protection materials
- Graduated with Honors

Polytechnic University of Valencia — *Valencia, Spain*

Aerospace Engineering Master — *Sept. 2014 - June 2016*

- Specialization in fluid dynamics and materials.
- Graduated with 83/100

Queen's University Belfast — *Belfast, United Kingdom*

Aerospace Engineering Degree — *Sept. 2013 - June 2014*

- Study abroad year
- Focus on aircraft design

Polytechnic University of Valencia — *Valencia, Spain*

Aerospace Engineering Degree — *Sept. 2010 - June 2014*

- Specialization in fluid dynamics and aircraft design
- Graduated with 85/100

Experience

University of Illinois Urbana-Champaign — *Illinois, USA*

Postdoctoral Researcher — *February 2023 - Present*

Studying the process of carbon deposition on carbon fiber materials and its effect in thermal protection systems with Professor Kelly Stephani.

- Develop accurate gas-surface interaction model for deposition process in Cantera.
- Design and carry out experimental campaign to validate model.
- Post-test sample characterization.

NASA Ames Research Center — *California, USA*

Research intern — *July 2018 - Sept. 2018*

Participated at the NASA Ames summer program in the group of Dr. Mansour to study the pyrolysis of the Phenolic Impregnated Carbon Ablator (PICA).

- Proposed a competitive kinetic model for PICA based on literature data.
- Improved optimization framework with bayesian inference.
- Wrote a journal publication [8]

NASA Ames Research Center — *California, USA*

Research intern — *July 2017 - August 2017*

Participated at the NASA Ames summer program in the group of Dr. Mansour to study the pyrolysis of the Phenolic Impregnated Carbon Ablator (PICA).

- Proposed a multicomponent model for PICA based on literature data.
- Developed a framework for optimization of kinetic parameters using Dakota and PATO.
- Wrote a journal publication [9]

Von Karman Institute for Fluid Dynamics *Belgium*

Research Master Project *Sept. 2016 - June 2017*

Project continuation of my Master's thesis entitled: "Experimental characterization and simulation of pyrolysis phenomenon: From carbon composite ablators to Pacific islands plant biomass".

- Experimental analysis of both aerospace heat shield and biomass materials.
- Investigation of the state of the art of the pyrolysis modelling.
- Numerical simulations on two different FVM codes (OpenFOAM and Gpyro).

Reviewer for Scientific Journals

Published in:

- Defence Technology, Elsevier.
- Industrial & Engineering Chemistry Research, American Chemical Society.
- Composites Communications, Elsevier.

Skills

Programming	Python, Matlab, Fortran, C++, HTML & CSS
Simulation and Design	OpenFOAM, Cantera, ANSYS, SolidWorks, Modelica
Analysis techniques	Thermogravimetric Analysis, Differential Scanning Calorimetry, Laser Flash Analysis, Infrared thermography Scanning Electron Microscopy, Mass spectrometry, Raman spectroscopy
Languages	Spanish, English, Catalan, French

Awards

2017	**Fellowship,** Strategic Basic Research PhD	*Research Foundation – Flanders (FWO)*
2017	**Graduated with Honors,** Research Master	*von Karman Institute*
2016	**Fellowship,** Research Master	*NATO von Karman Institute*
2013	**Erasmus,** Queen's University Belfast	*UK*
2010-2016	**Honors in Univeristy courses,** Thermodynamics, Fracture mechanics, Aerosp. Traffic Control	*UPV, Spain*

Teaching and Mentoring

University of Illinois Urbana-Champaign *USA*

Grad student mentor *Feb. 2023 - Present*

Mentor of two grad students at UIUC. Provide support on their work on both experimental and numerical aspects.

University of Illinois Urbana-Champaign *USA*

Lecturer for Intermediate Gas Dynamics *Sept. 2023 - Jan. 2023*

Lecturer for part of the course on Intermediate Gas Dynamics course (ME 410) at UIUC. Course focuses on compressible flows, flows with smooth and abrupt area change, with friction, with heat addition, and with mass addition, flows with weak and strong waves, and shock waves.

von Karman Institute for Fluid Dynamics *Belgium*

Thesis Advisor *Sept. 2017 - Jan. 2023*

Supervised master students during their master thesis at the VKI on a variety of topics related to my research.

- Time management and task definitions.
- Expand my field of research topics.
- Several works published in journal or conferences.

von Karman Institute for Fluid Dynamics *Belgium*

Hands on Machine Learning for Fluid Dynamics *07 Feb. 2022 - 11 Feb. 2022*

- Developed part of the course curriculum with Prof. Mendez.
- Lectured Python programming and exercises relevant to ML.
- Course with 150 atendees

von Karman Institute for Fluid Dynamics *Belgium*

Python and other IT tools for Fluid Dynamics *Dec. 2019*

- Series of seminars to introduce Python at the VKI.
- Program included: basics, HPC, OOP, and software packaging.
- Introduced several tools such as versioning with git, integrated development environments, bash/zsh, etc.

von Karman Institute for Fluid Dynamics *Belgium*

Tools for Scientific Computing *2020, 2021, 2022*

- 1 ECTS course from the VKI Research Master program.
- Developed the curriculum for the course with Prof. Mendez.
- Introductory course of programming in Python for scientists.

von Karman Institute for Fluid Dynamics *Belgium*

Measurement Techniques Laboratory: Infrared temperature measurements *2017, 2018, 2019, 2020*

- Lab advisor for research master students.
- Evaluate lab work, reports and oral exam.

Outreach activities

IMFAHE *USA*

Mentor *2023, 2024*

Participated in IMFAHE non-profit organization mentoring program to help young graduates pursue their future. Mentored three MSc students to discover the best paths for their careers.

Polytechnic University of Valencia *Spain*

Mentor *2020, 2021, 2022*

Participated in mentoring program at my home university to provide guidance to young graduates.

Talk cosmic to me *Belgium*

Organizer *2019, 2020*

Took part in the organization of several science dissemination events.

Carcaixent *Spain*

Invited speaker *Dec. 2019*

Invited speaker in my town city hall to describe my PhD activities to teenagers.

Professional Societies

2023 American Institute of Aeronautics and Astronautics (AIAA): Young professional member

2022 International Mentoring Foundation For The Advancement Of Higher Education (IMFAHE)

2017 VKI Alumni Association

Journal articles

1. Tovey, S., Zills, F., **Torres-Herrador, F.,** Lohrmann, C., Brückner, M. & Holm, C. MDSuite: comprehensive post-processing tool for particle simulations. *Journal of Cheminformatics* 15, 19. ISSN: 1758-2946 (Feb. 2023).
2. **Torres-Herrador, F.,** Eschenbacher, A., Blondeau, J., Magin, T. E. & Geem, K. M. V. Study of the degradation of epoxy resins used in spacecraft components by thermogravimetry and fast pyrolysis. en. *Journal of Analytical and Applied Pyrolysis* 161, 105397. ISSN: 0165-2370 (Jan. 2022).
3. Turchi, A., **Torres-Herrador, F.,** Helber, B., Pintsuk, G., Zuber, C., Ritter, H. & Magin, T. E. Thermal Conductivity Evolution of Carbon-Fiber Ablators Submitted to High Temperatures. *Journal of Thermophysics and Heat Transfer,* 1–11 (June 2022).
4. Coheur, J., **Torres-Herrador, F.,** Chatelain, P., Mansour, N. N., Magin, T. E. & Arnst, M. Analytical solution for multi-component pyrolysis simulations of thermal protection materials. en. *Journal of Materials Science* 56, 6845–6860. ISSN: 1573-4803 (Apr. 2021).
5. **Torres-Herrador, F.,** Eschenbacher, A., Coheur, J., Blondeau, J., Magin, T. E. & Van Geem, K. M. Decomposition of carbon/phenolic composites for aerospace heatshields: Detailed speciation of phenolic resin pyrolysis products. en. *Aerospace Science and Technology* 119, 107079. ISSN: 1270-9638 (Dec. 2021).
6. **Torres-Herrador, F.,** Turchi, A., Van Geem, K. M., Blondeau, J. & Magin, T. E. Determination of heat capacity of carbon composites with application to carbon/phenolic ablators up to high temperatures. *Aerospace Science and Technology* 108, 106375. ISSN: 1270-9638 (Jan. 2021).
7. **Torres-Herrador, F.,** Leroy, V., Helber, B., Contat-Rodrigo, L., Lachaud, J. & Magin, T. Multicomponent Pyrolysis Model for Thermogravimetric Analysis of Phenolic Ablators and Lignocellulosic Biomass. *AIAA Journal* 58, 4081–4089. ISSN: 0001-1452 (May 2020).
8. **Torres-Herrador, F.,** Coheur, J., Panerai, F., Magin, T. E., Arnst, M., Mansour, N. N. & Blondeau, J. Competitive kinetic model for the pyrolysis of the Phenolic Impregnated Carbon Ablator. en. *Aerospace Science and Technology* 100, 105784. ISSN: 1270-9638 (May 2020).

9. **Torres-Herrador, F.,** Meurisse, J. B. E., Panerai, F., Blondeau, J., Lachaud, J., Bessire, B. K., Magin, T. E. & Mansour, N. N. A high heating rate pyrolysis model for the Phenolic Impregnated Carbon Ablator (PICA) based on mass spectroscopy experiments. *Journal of Analytical and Applied Pyrolysis* 141, 104625. ISSN: 0165-2370 (Aug. 2019).

Conference papers and presentations

1. **Torres-Herrador, F.,** Gosma, M. & Stephani, K. A. *Understanding coke formation on carbon/phenolic materials* in *20th International Planetary Probe Workshop* (Marseille, France, Aug. 2023).
2. Helber, B., **Torres-Herrador, F.,** Turchi, A., Magin, T., Chazot, O., Denis, A., Zuber, C., Reimer, T., Pintsuk, G., Pinaud, G., Congedo, P., Hemberger, F. & Girolamo, D. *RECHAR: Assessment of Reliable Material Characterisation Methods for Charring Ablators* in *2nd International Conference on Flight Vehicles, Aerothermodynamics and Re-entry Missions & Engineering (FAR)* (ESA, Heilbronn, Germany, June 2022).
3. Martins, D., **Torres-Herrador, F.,** Helber, B., Turchi, A., Gamboa, P. & Magin, T. *Simulation of heat transfer of carbon fiber felts and microstructure effects on thermal conductivity of carbon/phenolic ablators* Lexingotn, Kentucky, Nov. 2022.
4. **Torres-Herrador, F.,** Tovey, S., Helber, B., Turchi, A., Blondeau, J., Van Geem, K. & Magin, T. *Investigating the Graphitization of Carbon and its Effect by Means of Multi-Scale Numerical Simulations* in *2nd International Conference on Flight Vehicles, Aerothermodynamics and Re-entry Missions & Engineering (FAR)* (ESA, Heilbronn, Germany, June 2022).
5. **Torres-Herrador, F.,** Tovey, S., Zills, F., Lohrmann, C., Magin, T. & Holm, C. *MDSuite: comprehensive post-processing tool for molecular dynamics simulations* Lexinton, Kentucky, Nov. 2022.
6. Tovey, S., Holm, C., Zills, F. & **Torres-Herrador, F.** *MDSuite: A post-processing engine for particle simulations.* in *Bulletin of the American Physical Society* (American Physical Society, Mar. 2022).
7. Turchi, A., Helber, B., **Torres-Herrador, F.,** Fagnani, A., Magin, T., Chipperfield, L., Pascon, F. & Ritter, H. *Ablative Material Numerical Test Case Series - from Experimental Tests to Numerical Results* in *2nd International Conference on Flight Vehicles, Aerothermodynamics and Re-entry Missions & Engineering (FAR)* (ESA, Heilbronn, Germany, June 2022).
8. Anfuso, E., Demange, S., Fagnani, A., **Torres-Herrador, F.,** Mendez, M. A. & Chazot, O. *Multiscale Modal Analysis of a Plasma Jet: Coherent Structures and their Observability* in *AIAA AVIATION 2021 FORUM* (American Institute of Aeronautics and Astronautics, Virtual Event, Aug. 2021).
9. **Torres-Herrador, F.,** Rico-Orero, J., Helber, B., Turchi, A., Hubin, A., Blondeau, J., Chazot, O. & Magin, T. E. *Graphitization of carbon fibers submitted to high temperatures and its effects on thermal conductivity* 2021 AIAA AVIATION Forum, June 2021.
10. **Torres-Herrador, F.,** Coheur, J., Blondeau, J., Meurisse, J., Panerai, F., Lachaud, J., Magin, T. & Mansour, N. N. *Comparison between traditional and competitive reaction models for the pyrolysis of high temperature aerospace materials* in *AIAA Aviation 2019 Forum* (American Institute of Aeronautics and Astronautics, June 2019).
11. **Torres-Herrador, F.,** Helber, B., Turchi, A., Gorugantu, S., Van Geem, K. M., Chazot, O., Magin, T. & Blondeau, J. *Characterization of the thermal degradation of the carbon-phenolic materials: an experimental effort on the ZURAM ablator.* in *International Conference on Flight vehicles, Aerothermodynamics and Re-entry Missions and Engineering* (ESA Publications Division, Monopoli, Italy, Sept. 2019).
12. Turchi, A., Helber, B., **Torres-Herrador, F.,** Fagnani, A., Magin, T. E., Chipperfield, L., Pascon, F., van Eekelen, T. & Ritter, H. *Ablative-material numberical-test international series (AblaNTIS): an experimental/numerical effort to support the validation of material thermal-response tools* in *International Conference on Flight vehicles, Aerothermodynamics and Re-entry Missions and Engineering* (Monopoli, Italy, Sept. 2019).
13. **Torres-Herrador, F.,** Blondeau, J., Panerai, F., Meurisse, J., Magin, T. & Mansour, N. N. *Advances on pyrolysis modelling for aerospace applications* Burlington, Vermont USA, Sept. 2018.
14. **Torres-Herrador, F.,** Helber, B., Blondeau, J., Chazot, O. & Magin, T. E. *Experimental characterization and numerical modelling of space debris degradation during atmospheric re-entry.* von Karman Institute, Mar. 2018.
15. **Torres-Herrador, F.,** Magin, T. E., Helber, B., Turchi, A., Fagnani, A. & Chazot, O. *Material properties and ablation performance of the ZURAM ablator for material response code validation* in *10th Ablation Workshop* (Burlington, Vermont USA, Sept. 2018).
16. Helber, B., **Torres-Herrador, F.,** Leroy, V., Turchi, A., Chazot, O. & Magin, T. E. *Experiments of the ZURAM carbon-phenolic ablator for test case definition and material code validation.* in *9th Ablation Workshop* (Bozeman, Montana USA, Aug. 2017).

17. **Torres-Herrador, F.,** Magin, T. E., Hollywood, A., Panerai, F., Meurisse, J. & Mansour, N. N. *Constructing a new pyrolysis model for carbon/phenolic ablators* Bozeman, Montana USA, Aug. 2017.

Book sections

1. **Torres-Herrador, F.,** Helber, B., Chazot, O., Magin, T. E., Van Geem, K. M. & Blondeau, J. in *12th VKI PhD Symposium* (von Karman Institute, Mar. 2021).
2. **Torres-Herrador, F.,** Helber, B., Chazot, O., Magin, T. E., Blondeau, J. & Van Geem, K. M. in *11th VKI PhD Symposium* (von Karman Institute, Mar. 2020).
3. **Torres-Herrador, F.,** Helber, B., Blondeau, J., Chazot, O. & Magin, T. E. in *10th VKI PhD Symposium* (von Karman Institute, Mar. 2019).
4. **Torres-Herrador, F.,** Helber, B., Blondeau, J., Chazot, O. & Magin, T. E. in *9th VKI PhD Symposium* (von Karman Institute, Mar. 2018).

Technical notes

1. **Torres-Herrador, F.,** Helber, B. & Turchi, A. *ReChar: Standard test procedures draft* tech. rep. TN4 (von Karman Institute for Fluid Dynamics, Oct. 2022).
2. **Torres-Herrador, F.,** Helber, B., Pintsuk, G., Reimer, T., Hemberger, F. & Zuber, C. *ReChar: Test report of the test activities defined in TP1a* tech. rep. TN3 (von Karman Institute for Fluid Dynamics, June 2021).
3. **Torres-Herrador, F.** & Helber, B. *ReChar: Identifcation of major challenges and interference sources* tech. rep. TN1.2 (von Karman Institute for Fluid Dynamics, Nov. 2020).
4. **Torres-Herrador, F.** & Turchi, A. *AblaNTIS: Material Characterisation Test* tech. rep. TN2.2 (von Karman Institute for Fluid Dynamics, July 2020).
5. **Torres-Herrador, F.,** Coheur, J., Blondeau, J., Meurisse, J. B. E., Panerai, F., Magin, T. E. & Mansour, N. N. *Advances on pyrolysis modeling for aerospace applications* tech. rep. (NASA ARC, 2018).
6. **Torres-Herrador, F.,** van Eekelen, T., Chipperfield, L., Turchi, A. & Magin, T. E. *AblaNTIS: Detailed work plan* tech. rep. TN1 (von Karman Institute for Fluid Dynamics, May 2018).

Co-supervised master theses

1. Martins, D. *Modelling and Simulation of woven TPS materials* (VKI RM, 2023).
2. Keay, H. *Understanding the graphitization process of carbon fibers* (KTH and VKI, 2022).
3. Boubker, Y. *Numerical simulations of thermal response of carbon composites submitted to high temperatures* (Vrije Universiteit Brussel/VKI, 2021).
4. Lamonte, A. *Evaporation modelling based on thermogravimetric analysis* (Vrije Universiteit Brussel/VKI, 2021).
5. Anfuso, E. *An investigation of the dynamics of plasma jet flows using data driven modal analysis* (von Karman Institute for Fluid Dynamics, 2020).
6. Rico-Orero, J. *Computational study on the effect of the microstructure on macroscopic properties for carbon fiber felts* (von Karman Institute for Fluid Dynamics, June 2020).
7. Cantos Trigo, S. S. *Development of stereo 3D reconstruction software* (von Karman Institute for Fluid Dynamics, 2019).
8. Garcia Guillamon, C. *Heat capacity determination of new lightweight ablators* (von Karman Institute for Fluid Dynamics, 2018).