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| **Laboratoire de Transfert de chaleur et de masse (LTCM)**  **Faculté des Sciences Techniques de l'Ingénieur (STI)**  **Institut de Genie Mecanique (IGM)**   Prof. John R. ThomeEPFL STI IGM LTCM **Bâtiment ME, Station 9**  **CH-1015 Lausanne, Switzerland**  **e-mail: john.thome@epfl.ch**  **tél: +41 21 693 59 81/82 fax: +41 21 693 59 60** | | | Logo%20055%20600dpi%20LZW |
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Lausanne, November 21, 2013

**SUBJECT: Letter for Dr. Gustavo Rabello Dos Anjos**

Dear Sirs:

I am writing this letter for ***Dr. Gustavo Rabello dos Anjos*** regarding his work for my Laboratory of Heat and Mass Transfer at the EPFL. I confirm that Gustavo worked in the LTCM lab as a PhD student for about a three and a half year period and he finish his thesis in July, 2012.

Gustavo’s thesis was part of a Swiss National Science Foundation’ Nano-Tera program in the consortia project that I directed named CMOSAIC on interlayer cooling with microchannels for a future generation of 3D stacked computer chips, which had 5 other EPFL and ETH labs as partners, including IBM’s Zurich Research Laboratory. His principal objective was to develop a very high level numerical code capable of modeling two-phase flow in microchannels. He is did this within the framework of ALE, of which he was already an accomplished researcher from his MS thesis in Rio with his supervisor there. Here in the LTCM lab, he took his single-phase ALE code, developed during his MS thesis, and very greatly expanded it to cover two-phase flows. This was a major challenge and task in which he brought in a surface tension model, interface tracking, etc. He did a very significant contribution also on the variable and dynamic meshing/remeshing problem: developing new methods to generate/remove mesh points that tend to disperse or concentrate on the two-phase surface during flows and deformation of bubbles, together with reclaiming of distorted mesh points back into “healthy” mesh points using an innovative “flipping” mechanism. He has validated his code extensively against numerous well-know benchmarks and against some experimental test results. His code handles so far rising single or multiple bubbles and bubbles flowing in circular and non-circular microchannels, the latter the real objective of this thesis. He has a very aggressive plan of action for new features to add into his program: coalescence of bubbles, evaporation heat transfer, etc. I can say without doubt that all of this work and achievements are based on his own work, since I myself am not a numerical specialist. I can further say that various two-phase numerical experts coming to the LTCM lab have been very impressed with his code (Prof. Zun, Prof. Tomiyama, etc.). His PhD thesis was recommended for the EPFL PhD thesis prize by his examiners.

While the Arbitrary Lagrangian-Eulerian (ALE) formulation within the Finite Element Method (FEM) exists for single-phase flows, this is to my knowledge the first two-phase version and it is proving to be a very excellent and powerful simulation tool. Furthermore, his new code is fully 3D while very few 3D two-phase codes exist in the literature and are very “expensive” to run compared to his code. His work has been presented orally at several European Two-Phase Flow Group Meetings (in Udine in 2012 and Tel Aviv in 2011).

Recently, his first manuscript on his two-phase ALE code was accepted for publication in the *Journal of Computational Physics*: Anjos, G.R., Borhani, N., Mangiavacchi, N. and Thome, J.R. (2014). A 3D ALE Finite Element Method for Two-Phase Flows, *Journal of Computational Physics*, in press. He has a second journal paper accepted for publication and in press in a special journal issue on microscale two-phase flow and heat transfer in the journal *Heat Transfer Engineering* with his first numerical evaporation work. Furthermore, he will complete two more papers from his PhD thesis and follow-on work he did on his own time in these past 16 months since leaving the LTCM lab.

Gustavo has interacted a lot with several other numerical PhD’s in the LTCM lab and those of several other labs in the Mechanical Engineering Institute, and continues to interact with my lab’s numerical staff. In fact, I have invited him back twice as an ERCOFTAC Scientific Visitor, once last year and again this year in early December.

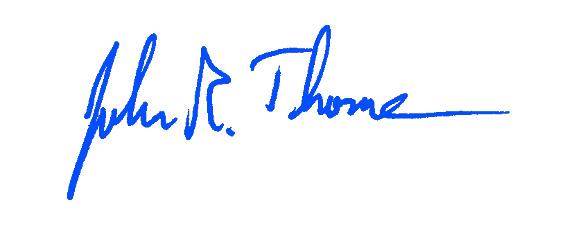
While in the LTCM lab, he has taken the opportunity to get well rounded on many topics beyond his own work. Naturally, he has a very extensive knowledge of all aspects of two-phase heat transfer and two-phase flows from his courses here, from his own work, and also from the large variety of two-phase research work going on in the LTCM lab on micro-PIV, micro-PSV, flow visualization, image processing, microchannel flow boiling, two-phase flow control, electronics cooling, etc. In particular, I very much enjoy his social participation in the LTCM lab, as he is someone who brings others together to create the lab “spirit”.

Gustavo has many innovative ideas and sorts these out first on his own, then showing me once he has accomplished these new features in his ALE code. He has made numerous presentations on it within our CMOSAIC project and at “numerical” workshops and summer schools in Brazil, some of which he participated in using his vacation time…hence he has gained a good amount of experience in public speaking. He is a very good speaker who engages all when giving seminars on his numerical work…not so many young CFD researchers can do that. His goal is to continue on with an academic career and I am sure he will make an excellent professor. I believe that his code has become a very valuable research tool that has a long solid future in it…it has many advantages compared to VOF methods…especially giving a very sharp representation of the two-phase interface and its features.

Gustavo gained some limited experience in directing the work of others while in the LTCM lab in helping to supervise student projects, visiting students, etc. He speaks English very well, he is articulate, and he is a diligent and motivated person. His English writing skills are now well advanced.

In summary, I wish to give my very, very strong recommendation to ***Dr. Gustavo Rabello dos Anjos*** for his future career in research and education. I have absolutely no doubt that he will excel and that we will hear much more from him in the future.

Regards,



Professor John R. Thome

Director, Laboratoire de Transfert de Chaleur et de Masse

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Norberto

Dear Professor Jacopo Buongiorno

I am pleased to write a reference letter for the candidate Gustavo dos Anjos to the Post-doc position in CMFD group at MIT.

I met Mr. Gustavo dos Anjos while he was an undergraduate student at the Mechanical Engineering Department in the Rio de Janeiro State University, in 2003. He was an outstanding student, showing excellent intellectual ability, great interest in research, and ranking first in his class.

I was co-adviser (together with Prof. Pontes) during his master studies at Federal University of Rio de Janeiro, from March 2005 to March 2007. During his master studies he deepened his theoretical background in mathematics and physics of fluids, and developed his computational skills, implementing a three-dimensional flow simulator solving the incompressible Navier-Stokes equations using the Finite Element method. The code was developed employing the object-oriented paradigm, prototyped in Matlab and implemented in C++.

After the successful conclusion of his M.Sc. program, he worked for approximately 9 months at the GESAR/UERJ research group, under my coordination, in a project dealing with the development of a Finite Elements based software for simulation of the water quality in hydroelectric dams. During this development, he also coordinated a group of programmers, showing very good interpersonal skills.

I have continued collaboration with Gustavo dos Anjos while he pursues his Ph. D. at EPFL with Prof. Thome. He is currently finishing two more research papers with results of his M.Sc. and later work developed at GESAR. I am aware of his later research as a Ph.D. student, developing a novel FE methodology for simulation of two-phase flows, and I consider his is doing an excellent work.

In my opinion, he is an excellent researcher, with excellent analytical and theoretical skills, as well as excellent computational background.

Please feel free to contact me if you need any additional information about the candidate.

Sincerely,

Norberto Mangiavacchi

Coordinator of the Graduate program in Mechanical Engineering

State University of Rio de Janeiro, Brazil

<http://www.eng.uerj.br/prof/norberto>