

## Summary of scientific achievements for Marie Curie ITN cQOM

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**Principal Investigator: Prof. Dr. Khaled Karrai**

**Academic/Industrial Institution: attocube systems AG**

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**Start Date of ITN fellowship: 01/10/2013**

**End Date: 30/06/2015**

Arriving to attocube at the beginning on October 2013 from the academic world, I had to go through extensive trainings in every department in the company. This includes the InnoVision department (where I worked), the positioning department where the slip-stick positioners are fabricated, the microscopy department where the attocube cryostats and microscopes are fabricated, and the marketing and sales department where I learned a lot about the company operation and road maps. Shortly after I took part at the Munich work-shop 'taking an idea to a product' by Prof. Dr. Khaled Karrai. There, I not only had the opportunity to learn more about the company and how it thinks and operates, but also met the CQOM family and learned about them.

Short while after my arrival, in attocube we have addressed a substantial part of the planned WP4 task. We decided to use the rest of the ER time to work on innovative piezo drive mechanisms towards increasing the speed and force and substantial reduction of wear of long range nano-positioners using the ultrasonic type piezo based motors (USMs). For that purpose I began to learn extensively about the field. You can imagine that as a chemist by education, and solid state physicist by trade, the topic of ultrasonic piezo-motors couldn't be further away from me, so it was a fantastic challenge. Another aspect that I had to overhaul was my complete ignorance in computational techniques, so I started to learn the COMSOL program that uses the finite element method (FEM).

Finding myself in a foreign country, I also took a language course, admitting that I never managed to learn German sufficiently (and consider this a failure on mine), it gave me the tools to at least understand simple questions and order food.

Still in 2013, a very nice workshop on the TRIZ (theory of the resolution of invention-related tasks) took place in attocube. TRIZ includes a practical methodology, tool sets, a knowledge base, and model-based technology for generating innovative solutions for problem solving. It is intended for application in problem formulation, system analysis, failure analysis, and patterns of system evolution. Although I hadn't had the opportunity to consciously use it in my work, I'm sure that part of what I learned unconsciously dripped into it.

In very short time we learned about the different approaches for the USMs both in the academic world and in industry. We started from designing and simulating already existing ideas so we could fabricate and test them with the objective to get even deeper understanding of the working of USMs. To compare the results of the FEM simulation and learn how good of a prediction we can anticipate and finally with the ambition to find the best possible approach and design something unique.

In April of 2014 I attended the 'Experimental toolbox for cavity optomechanics' workshop in Paris, where I had another opportunity for networking with the young scientist in the ITN and learn even more about their work in the field as well as the subjects of 3D printing and Python programming.

In July 2014 I attended the FEM workshop in Lausanne. This workshop came just in the right time as I felt that I had hit the wall with my simulation abilities. The workshop topics were nicely organized and taught novice users and more advanced one like me a lot of new tools and techniques we could apply in our simulation. On my return to attocube, and after we finished testing the first prototypes, I applied this new knowledge to get even deeper understanding into the workings of the USMs. We showed that the FEM simulation is an extremely valuable tool not only in academy but also in industry, where it can shorten the delivery time quite substantially due to very good predictability of the real world results.

In December of 2014 a colleague of mine and I took the Threon 'project Management Excellence' Training-Project Management Best Practices through the PMI® PMBOK® Guide based theory. We learned the practice of project management, on how to initialize a project, what must be taken into account, how to manage the people in the project and the project itself and eventually how to close it. Again this new acquired knowledge helped me in my project in attocube and will definitely be extremely important in my future endeavours.

In attocube, we managed to pinpoint the best possible approach and learned about our freedom of operation in the field. Only after we acquired all this information we could start looking for our unique idea, which came eventually and was coined to be the '3D Ultrasonic standing wave'. With the help of FEM simulation we not only refined the idea, but we proved that it's a completely new approach from anything else presented in the academy or used by the industry. In the final stage of the project we fabricated and tested this new approach and eventually showed the proof of principle for it.

Attending the workshop in Diavolezza allowed me to present my work to other fellows of the ITN, and although this topic was far from them as well, they appreciated the long and hard path we took to achieve our goals.

During the project I had the fantastic opportunity to work with Prof. Dr. Karrai and his team in InnoVision department. Although at the beginning all of us were absolutely ignorant in the field of USMs, now we can say that with a productive teamwork, open mind approach and supportive atmosphere, we managed to become extremely educated in the field and to feel competent to compete with the best. The time in attocube taught me a lot, in the field of USMs, but especially in how a successive company should operate on every level, as well as learning about me and my abilities. All of this will be invaluable in my future. The project itself not only achieved its goals but also resulted in at least one interesting approach that will be pursued by attocube, where I wish them much success.

At this opportunity I also wish to thank the cQOM ITN team and the fellows for this amazing opportunity that couldn't be possible without them.