

00:00:08 Michael Cornish

Welcome to the mechanics of Materials Podcast from Imperial College London. Today we are talking with Doctor Dimitrios Bikos, a postdoc here at Imperial. We'll let Dimitrios introduce himself.

00:00:22 Dimitrios Bikos

Hello Michael, I'm Dimitris Bikos, a postdoctoral research associate at the Department of Mechanical Engineering here at Imperial College London.

00:00:31 Dimitrios Bikos

I have been part of the Imperial College community for the past six years, focusing my research around the characterisation of multiphase composite materials. My research has been driven by my curiosity to understand how the microstructure of multiphase materials influences the mechanical performance.

00:00:52 Michael Cornish

Excellent. And what exactly is your background?

00:00:55 Dimitrios Bikos

I completed my undergraduate degree in Mechanical Engineering at Aristotle University of Thessaloniki in Greece, specializing in structural integrity. During my studies, I developed an interest in the mechanics of materials and trying to understand how external loads affect structures.

00:01:15 Dimitrios Bikos

This led me to do a final year project focusing on optimizing parabolic lift springs, which are part of a special system in heavy duty truck vehicles using finite element methods.

00:01:26 Dimitrios Bikos

My research aimed to reduce the weight of these springs, while maintaining a constant tolerance in fatigue.

00:01:35 Dimitrios Bikos

The outcome of this project, so the potential of 50% reduction in weight in certain group of lift springs.

00:01:44 Dimitrios Bikos

So then in 2017 I joined Imperial College to do my PhD in mechanical engineering. The project of my PhD was in collaboration with four academics, Maria Charalambides, Yannis Hardalupas, Marc Masen, and Philippa Cann,

00:02:00 Dimitrios Bikos

From three different divisions in our department, which are the mechanics of materials, thermal fluids and tribology, and we had another PhD student working in the same project with me. And in this project we investigated the effect of macroaeration on the mechanical, thermal and tribological properties of chocolate, and their impact on food oral processing.

00:02:24 Dimitrios Bikos

The project was funded by Nestle and it was aligned with the government's needs to reduce the content of health-sensitive nutrients, leading the industry to modify their product formulations, but at the same time, aim to control or even improve the sensory aspect of their products.

00:02:43 Dimitrios Bikos

The outcome of this collaborative project was a computational tool which links chocolate composition with the mechanical, thermal and tribological breakdown of chocolate which is happening during oral processing and set the insights on how food structure affects their sensory perception.

00:03:01 Michael Cornish

So Dimitrios. Where do you work now and who are you working with inside the department?

00:03:06 Dimitrios Bikos

So in 2022, I completed my PhD and joined Soraia Pimenta's research group, which deals with research around fiber reinforced composite materials. And it's been a year and a half now that I'm a postdoc in this group and part of a large project called NEXTCOM, which aims to develop the next generation fibre forced composite materials for high performance application, which exhibits superior mechanical properties under longitudinal compressive loading.

00:03:33 Michael Cornish

What brought you to this research area?

00:03:36 Dimitrios Bikos

So the reason that I'm working on this area is twofold. The first regards my interest around the characterisation of multiphase composite systems and the microstructures and how changes at macroscopic level affect the material at real-life scale. This is something that always fascinates me.

00:03:54 Dimitrios Bikos

I like to think that the macro structure is the intermediate link between the manufacturing process and material properties. The way the material, in other words, is manufactured will affect its microstructure and in turn the way the material is structured will affect its behavior under the external load. Understanding this change of events is the way to develop optimised advanced composite materials.

00:04:18 Dimitrios Bikos

Being part of a larger group of academics and researchers is the other.

00:04:22 Dimitrios Bikos

It's really exciting to collaborate with so many people from different disciplines aiming to tackle a real life problem and see the contribution of its members to the ultimate goal.

00:04:32 Dimitrios Bikos

In my little academic experience, I have noticed that researchers from different fields think and approach problem differently and this actually really develops your perspective and helps you have a better idea around the problem.

00:04:47 Dimitrios Bikos

It's really common in real life problems that the solutions proposed from one field have a negative impact on the other. Therefore having a holistic approach to the problem is usually the way to go.

00:05:00 Michael Cornish

Now you mentioned just a moment ago that it's exciting to collaborate to approach real world problems. So what would you say are the primary real world problems that your research is aimed at?

00:05:10 Dimitrios Bikos

Although the main focus of the project is to improve the performance of fiber reinforced composites, the topic is aligned with government goals to move to net zero through the development of new, lightweight and optimised composite structures.

00:05:25 Dimitrios Bikos

Optimising the composite structure we can achieve an improvement in the lifespan and the energy efficiency of the material. This is particularly important for the transportation sector, where the development of new improved lightweight structures will assist the energy transition from the current one to the more sustainable alternatives.

00:05:47 Dimitrios Bikos

In addition, during the project we had actually parallel activities such as short term internships and student projects where the sustainability of the composite constituents was also considered.

00:05:59 Dimitrios Bikos

Note that our project course activity includes the development of new composite constituents, new composite architectures, and proposed advanced numerical methods and proto-experimental protocols to improve the performance of the composites.

00:06:14 Michael Cornish

So you've laid out several goals. What are some of the difficulties that you'll face when trying to achieve these goals?

00:06:21 Dimitrios Bikos

So one of the main challenges in the literature is the issue of the computational cost of these micro mechanical models. This originates from the complexity of the macro structure of these materials, which results to computational heavy models when we try actually to reconstruct the real geometry on a virtual environment.

00:06:40 Dimitrios Bikos

To overcome this issue, most micromechanical models in the literature either assume a very simplified microstructure, or consider volumes of materials that are too small to be considered representative.

00:06:54 Dimitrios Bikos

Often this simplification can provide misleading results and conclusions about the behavior of the composite.

00:07:03 Dimitrios Bikos

Fortunately, when we investigate and we focus on the effect of realistic composite microstructures, these limitation can be overcome by the new computational methodology we recently developed in the framework of this project and this computational approach can be actually used to run very efficient simulations of real composite microstructure, which are actually several orders marked larger than the models found in the literature, without compromising the accuracy of the results.

00:07:32 Dimitrios Bikos

To help you visualize the improvement in the computational cost of these models, the common micromechanical models in the literature only contain the volume of few tens

of fibers and requires a high performance computer to run and complete. And even then the simulation requires a few days to complete.

00:07:50 Dimitrios Bikos

On the other hand, with our new approach, a model can contain up to 2000 or even 3000 fibers and requires less than a day to complete, using a personal computer.

00:08:02 Michael Cornish

So who are the some of the other researchers working on this with you?

00:08:05 Dimitrios Bikos

I have to say that this is a highly multidisciplinary research team from four different departments from 2 UK institutions, the Imperial College London and the University of Bristol.

00:08:20 Dimitrios Bikos

The nice thing is that actually we meet regularly on a weekly basis with the members of the same work package, but also we're working closely with other work packages on tasks actually that's related to together.

00:08:34 Dimitrios Bikos

In order to receive or provide support, we all meet every month to present our work, monitor the progress of the individual activities and exchange ideas about challenges that we are facing. So this is a nice way to be on top of the task, but also be sure that what we are actually working on is impactful. But also novel for the field.

00:08:57 Michael Cornish

And finally, where does the funding come from? Do you have any industrial partnerships?

00:09:02 Dimitrios Bikos

Mainly this is a UK EPSRC project run.

00:09:05 Dimitrios Bikos

But we have a active collaboration with other universities and academic groups such as the University of Southampton, University of Oxford, but also outside the UK University of Vienna, the EPFL and few others.

00:09:19 Dimitrios Bikos

But apart from the academic collaborations with the universities, we have lots of industrial partners which supply the materials, but also advise us for the current needs from the industrial site. Just to highlight that we in total collaborate with 19 companies.

00:09:36 Dimitrios Bikos

To give a small example of the breadth of the industrial partners, we collaborate with the National Composite Center, the Airbus, BAE Systems, Nexus, Solvay and many others.

00:09:47 Michael Cornish

Well, thank you very much for speaking with us.

00:09:50 Dimitrios Bikos

Thank you Michael. It's nice being here.