**Michael Cornish**

Welcome. This is the mechanics of materials podcast. Today we're talking with Doctor LiLiang Wang. Dr Wang is part of the Faculty of Engineering in the Department of Mechanical Engineering here at Imperial College London. Doctor Wang's research experience is in metal forming and process modeling. Today, we're going to talk about aluminum alloys and how to make them stronger and lighter for both automobile and airplane applications.

**Michael Cornish**

So how long have you been in the department, then?

**LiLiang Wang**

For a long time I worked as a research associate, since 2009. I think the working environment here is really nice. Yeah, and the people, most importantly the people here, they're supporting each other, I feel it's like a family. Yeah. So that's why I stayed here for so long.

**Michael Cornish**

So have you been working on aluminum alloys this whole time?

**LiLiang Wang**

Uh, yes, I would say 90% of my research in the RA period and the early career period was focused on aluminum alloys. The project itself is called HFQ Technology, which is a new novel metal forming technology to form lightweight aluminum component with high strength.

**Michael Cornish**

Right.

**LiLiang Wang**

And the application is for the aircraft industry and automotive industry.

**Michael Cornish**

And so, how are you forming different kind of material types out of this aluminum alloy? Just the actual heating process and how specifically you heat it or is there, you know, is it what things you put into it as well?

**LiLiang Wang**

Exactly. Thank you. I think that's a very good question and many people ask me the same thing. We are using or we are developing a novel metal forming technology which is a hybrid. By the forming process, it combines forming and heat treatment in one single operation. So previously we only cared about the shape, so we formed, and if the shape or dimension of the components is accurate, then we are happy. But now that the novelty of this new technology, we call it HFQ or hot stamping, we form the part not only for accurate geometry, but also higher strength.

**LiLiang Wang**

So we run the heat treatment forming in one single operation. So we get two benefits out of one single action.

So this is the beauty or benefit of this new technology and this was invented by the head of the group, also the founder of the metal forming group, Professor Jianguo Lin. And he's a fellow of Royal Society of Engineering. He's a very global leader of metal forming research field and he was the key inventor of this technology. And I was quite proud to work on this technology.

**Michael Cornish**

So presumably the benefit then, if it's stronger, it means you can use less material and it's lighter. So in something like an aircraft or a car, you use less fuel per unit…

**LiLiang Wang**

Exactly.

**Michael Cornish**

… to move the same distance.

**LiLiang Wang**

Exactly, exactly. That's the idea. So in the automotive industry, for example, so everybody probably drives a car to work every day and for conventional cars, you're using petrol to drive the car and if the car body is very heavy, then obviously you have to use more petrol, more fuel.

**LiLiang Wang**

Actually, over 95% of the car bodies being used now are made of steel. The steel is very heavy. Obviously, if we can replace this steel by using aluminum alloys or some other lightweight materials then obviously the weight saving will cause a lot of impact. For aluminum alloys, if we replace the steel components, we can save the weight by up to 50%. This is huge impact and these 50% weight saving could lead to like 23% of petrol reduction and also 31% of CO2 reduction compared to the conventional steel body car. So the impact is very obvious, but in the meanwhile, we can't compromise the structural strengths of the body. So we have to make sure the aluminum components are strong as well. So they’re light but also they're very strong.

**Michael Cornish**

What stage would you say this research is? You know, are you close to being production level, or is it still kind of early stage?

**LiLiang Wang**

I would say we are doing research all the time, but I'm very happy to say, very excited to say that this technology has been used already. At the moment, we are focusing on the niche vehicle manufacturing industry. In the future, we hope that this technology can be used in the mass production mode and can be used in popular cars so that everyone can drive a lighter car. Following up your question, we're still doing research on this technology, because lightweighting can be improved theoretically, right? So we have aluminum alloys, we have hot stamping technology to form them into complex shapes.

**LiLiang Wang**

What is the next step? So in the future, the automotive industry is moving from lightweighting to rightweighting. The idea of lightweighting was to use the light materials as much as you can, for example, full aluminum body car. So this will obviously be lighter than the full steel bodied car. This is the conventional idea or the idea being used now, but in the future the automotive industry is going to move into rightweighting. So what is rightweighting? Rightweighting is to use the right materials into the right places so the future car body will not be a single material car body. Probably it will be a mixture of different light alloys or lightweight materials. It could include ultra high strength steel. It could be aluminum alloys, magnesium alloys or carbon fibre reinforced plastics, so composite materials.

So a mixture of different light alloys or different light materials will give you the ultimate reduction of weight and also the performance of the car will be better because the weight balance in terms of design point of view is better as well. So in order to support that, as a metal forming engineer and as a manufacturer, we will have to develop new technologies to meet this new target.

**Michael Cornish**

There's something really interesting you said, is that theoretically there's a lot more room to strengthen these materials. So some people may know that in thermodynamics, let's say there's kind of a maximum energy output, useful energy output of systems, and so we can gauge the relative, you know, where we are practically to where we could be theoretically. Is there a a similar concept in material science, where you can say, we actually know theoretically what is the maximum we can achieve? And where would you place yourself within the maximum?

**LiLiang Wang**

Yeah, I think you're absolutely correct. So we do have a limitation, but I think our boundary can be pushed by the material scientist. So by the way, we are working in mechanical engineering as manufacturing engineers. So unfortunately we don't develop the new materials, but we are working very closely together with the material scientists, so whenever they develop a new material then they need us to manufacture them into, like, a strong component in a low cost manner. So this is our job. So I do agree with you, from amaterial science point of view, probably there is a limitation but if we speak to them, they are always very proud and very creative and innovative. Perhaps one day they will develop novel materials which can be lighter or push the limit.

**Michael Cornish**

That's, yeah, that's absolutely excellent. Well, I'd like to thank you for taking the time to talk with us, to talk with the audience.

**LiLiang Wang**

Thank you.

**Michael Cornish**

And if you, do you have any research positions you'd like to advertise? Any positions in your group for any budding scientists coming your way?

**LiLiang Wang**

Yes, and we welcome talented students, talented researchers to join the metal forming group. You are always more than welcome. Please contact me directly by writing me an e-mail or even popping in or call me. You're more than welcome to join the metal forming group.

**Michael Cornish**

Excellent. All right. Well, thank you again.