

Eureka with Dr. Bikramjit Basu

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Doctor Bikramjit Basu (born 1973) is currently a Professor at the Materials Research Center and also holds an Associate Faculty position at Center for Biosystems Science and Engineering, Indian Institute of Science (IISc), Bengaluru. He is an Adjunct faculty at Indian Institute of Technology Kanpur (IITK). He has published over 225 peer-reviewed research papers. Besides two textbooks (one on structural ceramics and the other on tribology), he has edited a book on biomaterials. He is on the editorial boards of several important research journals. His extensive research work has enhanced our understanding of the 'complex synergistic interactions between the material properties (electrical conductivity/magnetization) and electric/magnetic field simulation towards cell functionality modulation *in vitro* on newly developed functional biomaterial surfaces'. He has played a key role towards the multi-institutional research programmes on biomaterials. He led important multi-institutional research programmes like Indo-US Science and Technology Forum funded Biomaterials Centre (2008-12) and United Kingdom (UK)-India Education and Research Initiative (2009-12). Currently, he is the principal investigator of a translational center of excellence at IISc with an interdisciplinary team of 15 active researchers from academia, national labs, hospitals and biomedical companies to translate lab-scale research to develop functional prototypes for orthopedic and dental restorative applications.

Dr Basu received his undergraduate and postgraduate degrees, both in Metallurgy, from National Institute of Technology (NIT, then known as Regional Engineering College), Durgapur and IISc, Bengaluru in 1995 and 1997 respectively. He obtained his Ph.D. degree in Ceramics from Katholieke University of Leuven, Belgium. After his Ph.D. he worked for a brief period as a Postdoctoral Fellow at the University of California, Santa Barbara (UCSB) and then came back to India in November 2001 to join Indian Institute of Technology (IIT), Kanpur as Assistant Professor. In 2011, he moved to the IISc. He has worked as Visiting Professor/Scientist at University Polytechnic Catalonia, Barcelona, Spain, University of Warwick, UK and Seoul National University, South Korea.

Prof. Basu's contributions in Engineering Science have been widely recognised. He is one of the youngest recipients from the Metallurgy/Materials Science community as well as the only Biomaterial Scientist so far to receive India's most coveted science award, Shanti Swarup Bhatnagar award (2013). He is an elected Fellow of the Indian National Academy of Engineering (2015), West Bengal Academy of Science and Technology (2014), Society for Biomaterials and Artificial Organs (2014) and National Academy of Sciences, India (2013). In 2015, he received National Bioscience award from the Government of India for unique contributions in the frontier areas of biological sciences. He remains the only Indian from India to receive the prestigious 'Coble Award for Young Scholars' (2008) from the American Ceramic Society. Other noteworthy awards include, 'Metallurgist of the Year' Award By the Ministry of Steels, Government of India (2010), Materials Research Society of India (MRSI) Medal (2011), and Young Scientist Awards from the Indian Ceramic Society (2003), Indian National Academy of Engineering (2004) and Indian National Science Academy (2004).

Gauhar Raza: Let me begin with a story set in 1947, East Bengal where a very large family comprising of sixteen children had to migrate to West Bengal. Everyone in this family valued education a lot, but faced extreme economic hardships. Consequently, the education of its thirteenth child was disrupted and he had to take up a job. While performing his duties in charge of a railway station, he did not allow his passion for education to diminish. When he became a father, he wanted his child to get the best of education in the country or abroad. The only problem was that this child always stood second in the class and for the family it was a matter of great concern. Though the child too was disturbed about not being first in the class and he worked hard to excel in his later life. Today we have Dr Bikramjit Basu, an outstanding scientist, with us in the studio. Do you remember your school where you studied sitting on the floor?

Bikramjit Basu: Yeah, I remember quite well. I started going to one railway school in a small town called Beldanga where my father was the stationmaster and I started my schooling by sitting on the floor.

Gauhar Raza: Did you feel you were like the lord of the railway station?

Bikramjit Basu: Not exactly because I was too little to realize that. But the one thing I remember was that when I was allowed to sit on the benches, I came back home and very excitedly told my mother that 'now I can sit on the benches and study'. So that was the one memory, which I still have.

Gauhar Raza: It was a very important moment in your life as a child.

Bikramjit Basu: That's right.

Gauhar Raza: From a small town you came to a bigger town to do your engineering. Though you wanted to do medical and become a doctor that you had to opt for engineering was very good as otherwise we would have lost a first-rate scientist. But was not getting into medical disappointing for you?

Bikramjit Basu: No, because once I decided that I will pursue engineering I really started loving it. I remember that I wasn't really very sure which particular engineering discipline I should take, but then we had a very close family friend, Dr Biman Ghosh, who was then lecturer at Shibpur Bengal Engineering College. He really knew me right since childhood and so he suggested me to take up metallurgical engineering.

Gauhar Raza: You didn't know anything about metallurgical engineering at the time and also where it was going to lead?

Bikramjit Basu: I only knew that it may have some relation with chemistry but to be honest I did not know anything more than that.

Gauhar Raza: Now the word metallurgical engineering is almost extinct. It is called material science and engineering these days. When did that switch over in your life happen? When did you start expanding your horizon? Instead of going to IIT Kanpur, you chose IISc Bangalore. Was that the turning point, which opened up your vision?

Bikramjit Basu: Yes, indeed it was true when I stood eleventh in Graduate Aptitude Test of Engineering.

Gauhar Raza: You could have chosen (to go to) any institute in the country.

Bikramjit Basu: I could have chosen IIT Kharagpur, which was closer to my home, but I chose IISc (Bangalore) because I (had) heard a lot about the Institute and I think that my decision was appropriate at that point of time.

Gauhar Raza: That was your decision? Nobody advised you?

Bikramjit Basu: That was my decision and it was strongly supported by my father and then I came to IISc. I was amazed by the scientific excitement and ecosystem of the institute and I must be quite honest (to say) that if I would not have come to IISc, I may not have pursued research as my career.

Gauhar Raza: Then why after coming back to India, after your post doctorate, you chose IIT Kanpur rather than IISc Bangalore?

Bikramjit Basu: I spent quite a few years abroad and being the only son there was a lot of pressure to homecoming. Whenever I used to come back from abroad my father used to always remind me that you have to come back to India and serve the country. So then....

Gauhar Raza: The reason for asking you to come back to India was that he wanted you to serve the country, and not because he was living in India.

Bikramjit Basu: No, he wanted me to come back to serve the country.

Gauhar Raza: That was the value system that you inherited from your parents and your older generations. So when you came back to India to serve the country why did you decide to join IIT Kanpur and not IISc?

Bikramjit Basu: Right, to be honest actually at that point of time I never applied for a faculty position in the IISc. I just applied to IIT Kanpur and it gave me the first offer. I asked my father shall I wait in the United States (US) to do some more years of postdoctoral work before coming back to India. He said no you got the first offer, you must come back and accept it. So I did that.

Gauhar Raza: You created an excellent laboratory there. But when did you decide to switch over to biosciences. In fact, it sounds very weird that someone excelling in ceramics suddenly switches over to biosciences.

Bikramjit Basu: I think I decided fairly early in IIT Kanpur, around 2005-06, to continue with engineering ceramics as it was the field in which I pursued my doctorate at Katholieke Universiteit Leuven, Belgium under the supervision of Prof. Omar Van Der Biest. But slowly I developed (interest in) the research programme on engineering ceramics, which was not a very mature field of research at IIT Kanpur. I had to struggle really hard to establish the whole set of laboratories. Subsequently, I thought that if I have to make a real impact on society, I would have to do something which would in some way influence human health.

Gauhar Raza: This confluence of physics, chemistry, biology, zoology and ceramics is wonderful. Why did you think that it was important to develop this area?

Bikramjit Basu: I will just give one example of materials for orthopedic applications. See, in total hip replacement we have the stem and we have the femoral ball head and then the femoral ball head goes inside the acetabular socket. This is one of the materials which was developed by our research group and this is called polymer-ceramic hybrid composite. I did not know anything about polymer when I was doing my Ph.D., but I learnt everything while I was at Kanpur.

Gauhar Raza: This was chemistry, pure chemistry.

Bikramjit Basu: And then I started doing research on that and I have done in vivo test in rabbit animal study. Fortunately, I had established quite a close relationship with Sree Chitra Tirunal Institute for Medical Science and Technology in Trivandrum and had quite good collaboration there. They helped me in doing all this animal testing in rabbit and we found the material biocompatible.

Gauhar Raza: Why was it important to develop that kind of material? Why couldn't you use anything else?

BikramjitBasu: It is important to develop this material because it is much better in terms of friction and wear resistance as compared to existing materials like ultra high molecular weight polyethylene in terms of physical properties and the biocompatibility properties are also not compromised, which is quite important. You'll be really happy to know that the technology is currently being transferred to an Indian company.

Gauhar Raza: A large number of people, who develop joint problems, would be benefited by this cutting-edge technology and science. How did you think that your research could be useful in space technology? It is mind-boggling that someone working on bones also works on something that useful in shaping the nozzle of a rocket.

BikramjitBasu: Actually, that was the extension of my Ph.D. research in IIT Kanpur, when I developed a strong interest in non-oxide ceramics and then during the early stage of my research, before I even entered into the biomaterials field, I thought that it would be much more relevant if I could develop some new materials and that was basically zirconium diboride-based material for re-entry space vehicles, and then we collaborated.

Gauhar Raza: We haven't developed re-entry space vehicles as yet.

BikramjitBasu: No.

Gauhar Raza: But then without developing the material for that we can never develop re-entry vehicles.

BikramjitBasu: That's right.

Gauhar Raza: But the same research you also used for nuclear technology. It's amazing that you begin with ceramics and then you go to bones of human beings and then you enter into space research and then you enter into nuclear research. How do you relate all that?

BikramjitBasu: Actually, the common thread that binds all the three areas is my fundamental understanding of developing ceramic materials and I exploited my basic understanding on ceramics and applied that to some of the strategic areas. I had one good student who is currently scientist at Bhabha Atomic Research Centre (BARC). When he did M.Tech. project with me, we developed titanium diboride-based materials, which can perhaps be used in the country's high-temperature nuclear reactor in the near future.

Gauhar Raza: This is amazing how sciences come together to create new things. Dr Basu how do you see the future of materials sciences in the country. We are investing a lot of money in this field. This is public money. Do we need to spend so much?

BikramjitBasu: I think so, but I think we need to be accountable and see how this financial support to scientists finally helps India to prosper in some of the strategic sectors, like nuclear, space and more importantly in healthcare. India is such a vast country of over one billion and I think (this would be justified) if we can solve some of the challenging problems related to human healthcare.

Gauhar Raza: You have been working at the cell level, especially in vitro level. Would you like to tell us something about that?

BikramjitBasu: Yeah sure, typically one of the common pathways that biologists take is that they use some of the biochemical growth factors to induce the differentiation of human stem cells. I give the example of stem cells because many common people can relate to stem cells. What our research group has shown.

Gauhar Raza: To many people it would be amazing that a person who started his career in ceramics would be an expert in stem cells. Please go ahead.

Bikramjit Basu: I'm not saying I'm an expert on stem cells but still we use stem cells in our research. What we have shown is that if you grow stem cells on electrically conductive biomaterial substrate and apply that external electric field in a very intelligent, regular and periodic manner, then you can essentially guide the stem cells to differentiate to neural cells.

Gauhar Raza: Absolutely.

Bikramjit Basu: We have shown (that) through in vitro experiments. There we have done a lot of Polymer Chain Reaction (PCR) analysis to understand the underlying reasons behind this differentiation. Extending that similar research recently one of my Ph.D. student...

Gauhar Raza: Suppose we understand the way the differentiation takes place, what is its use for the common man?

Bikramjit Basu: The common use is that suppose if you make an implantable material for neural tissue applications and if the scaffold is loaded with stem cells and if you apply the electric field, in the same manner that we have done at the in vitro level, we expect that stem cells will differentiate to neural cells.

Gauhar Raza: (Essentially this would mean) If there is some deficiency then it can be overcome. If there is a problem with the growth of cells in someone's body then probably we can control it.

Bikramjit Basu: That's right.

Gauhar Raza: A lot of diseases can be controlled by mastering this technique. You have been doing wonderful research and probably you have fulfilled your dream and your parents' dream of serving the country. You've been handling many international projects. Do you feel that in your area we now stand at par with other countries?

Bikramjit Basu: With respect to many of the developing nations the answer is yes, but if we compare India with respect to the United States or other Western countries, for example Germany or France in the area of biomaterials, I would still say that.

Gauhar Raza: We are far behind?

Bikramjit Basu: We have a long way to go.

Gauhar Raza: Why is it so? Is it because of the lack of money or brainpower?

Bikramjit Basu: I think that at present we should not complain about financial support because the government has been very kind to support research, much more so in the last one decade.

Gauhar Raza: But last year was a bad year for most scientists, yes?

Bikramjit Basu: Yes, but to encourage the area of biomaterials we need to follow the American model. For example, in American universities they have hospitals in many of the major universities where large biomaterials programmes have been set up. That kind of ecosystem does not exist here and it needs to be built in the country.

Gauhar Raza: You have done wonderful work and probably created one of the best laboratories in the world and now you have shifted to IISc Bangalore. Your contribution has been applauded and recognized both by the scientific community in the country and abroad. You got the Coble Award for Young Scholars from the American Ceramic Society and the Shanti Swarup Bhatnagar Prize, the most coveted award in the country at very young age. Which one of the two do you value the most?

Bikramjit Basu: I think both the awards are equally satisfying. As far as the Robert L. Coble award from American Ceramic Society is concerned, I am till today the only Indian to receive the award and I received that award in Pittsburgh, United States of America (USA) and the second one of course, as you said, the Shanti Swarup Bhatnagar Award (was equally prestigious). Actually more than me my father was extremely delighted.

Gauhar Raza: What was the moment of eureka in your life? When did you say that yes I have found something new, yes, I have achieved something that had not been achieved by anybody else or I wanted to achieve that?

Bikramjit Basu: I think the work which was recognized by the Bhatnagar committee was that the electric field stimulation of biological cells on implantable biomaterials substrate. I think when we started this work way back in 2006-07 with one of my Ph.D. students, we did a lot of theoretical study and then subsequently validated the study with experiments. I think that is one of the turning points in my career and at that point, I thought perhaps I've started something new in my research career.

Gauhar Raza: Would you like to give a message to the younger generation?

Bikramjit Basu: I think for the younger generation, I must say that science and research really hold great promise in our country because now there are so many avenues which can support research of young scientists and young assistant professors. Such avenues were not available when I started my career at IIT Kanpur in 2001. I think the only other thing I must say is that 'if you have fire in the belly, you can achieve anything'.