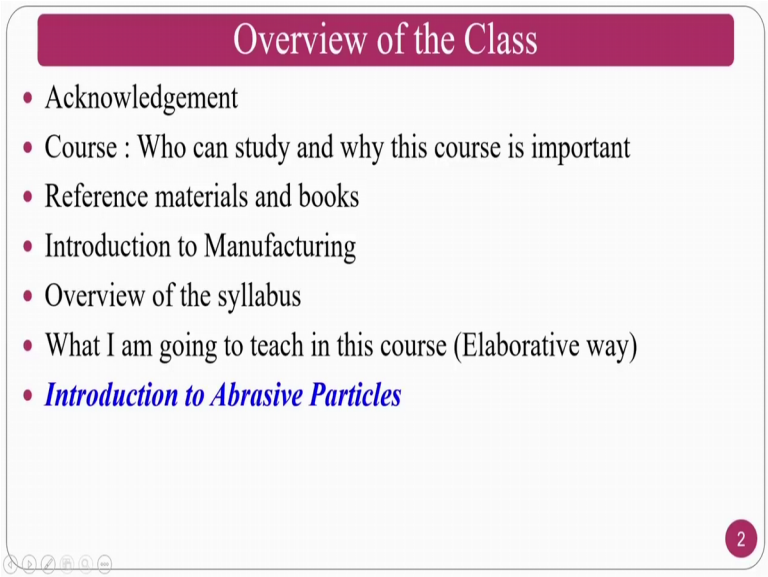
Introduction to Abrasive Machining and Finishing Processes

Dr. Mamilla Ravi Sankar
Department of Mechanical Engineering
Indian Institute of Technology, Guwahati

Lecture- 01
Introduction to Abrasive Machining and Finishing Processes

Welcome to my course on Introduction to Abrasive Machining and Finishing Processes and myself Doctor Mamilla Ravi Sankar. I am assistant professor in Department of Mechanical Engineering in IIT, Guwahati ok. So, the first and foremost thing that I am going to deal with is, what I am going to talk about in this particular course and in a summary way as well as in the elaborative way. So, that you can choose whether you want to take this course or not or why this course is important other things ok.

(Refer Slide Time: 01:05)



Coming to the overview of the class in particularly what I am going to talk, just I acknowledge those people who are helping from the background are who are helping technically non technically and all those things, and the why and who can study this course. So, reference materials which are also a part of this course.

So, that you can refer to the books and papers relevant to this particular course, Introduction to Manufacturing because abrasive machining and finishing process comes under a category of manufacturing. So, just a glimpse why manufacturing is important

and other things I will study, other things I will explain. Overview of the syllabus in a normal way, what are the overview content and all those things and I am also going to talk about in an elaborative way the same things. So, introduction to abrasive particles, before you are going to study about this particular course what is an abrasive particle, how can you measure the size, what are the varieties, what about the cutting edges, what are the rectangles and all those things

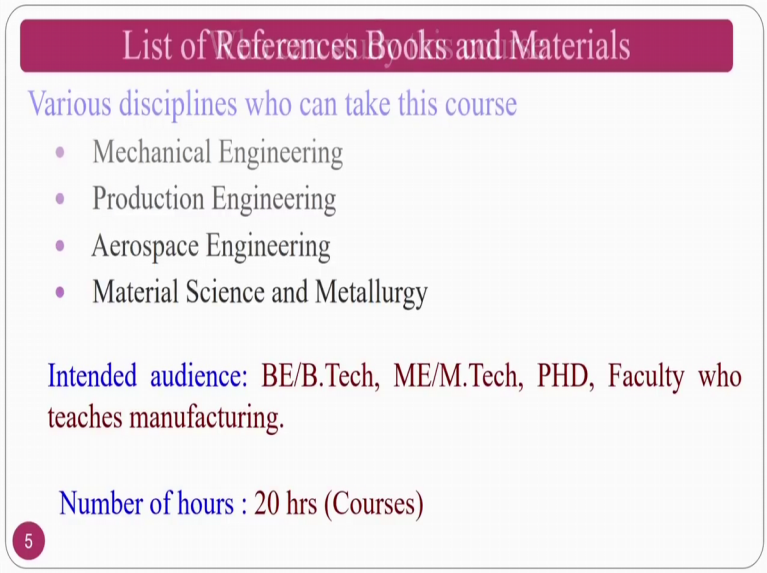
The manufacturing of abrasive particles how this abrasive particles are fabricated and the size and shape of an abrasive particle, how do you determine the size of abrasive particle and I conclude this particular class with a summary of the class, what I am going to talk in this particular class. So, the acknowledgement goes. I am very thankful for Professor Khijwania, he is the head centre for education technology and who gave me this opportunity to explain this particular course or disseminate my knowledge about this particular course on Introduction of Abrasive Machining and Finishing Process. He is the person who is controlling all these things I am very thankful for the staff who tirelessly working for the editing taking the video and preprocessing post processing and other things, who are there at the centre for education technology head of the department of mechanical engineering, where I belongs to Professor Dwivedy ji.

(Refer Slide Time: 03:22)

And thanks to the MOOCs and IIT Guwahati in broad spectrum, thank you for those who are helping hands for me in this particular course my Tas Jayanth Reddy Abhishek

Gupta, Mandeep Saini and Rawat these are the people. Apart from all this people I would like to acknowledge one person who helped me technically he is Narayan Reddy he is no more. So, he is very good friend of me he helped me in many ways. So, technically he helped me a lot coming to the course on overview of my course on introduction to abrasive machining and finishing processes who can study this course.

(Refer Slide Time: 04:07)



So, normally this is particularly very helpful for mechanical engineers, production engineering people, aerospace material science and metallurgy people. And more over it can also helpful for other departments who want to learn about manufacturing and all those things. In the intended audience it can be useful for the B Tech students where you can learn basics, M Tech and PHD students you can learn a basic as well as you can take up some of the course contents as they your research topics, faculty who teaches manufacturing in particularly about the machining processes.

So, as you know this particular course comes under the subtractive manufacturing. So, number of hours is 20 hours course. So, I am going to take this particular course in 20 hours. List of the reference books.

(Refer Slide Time: 05:01)

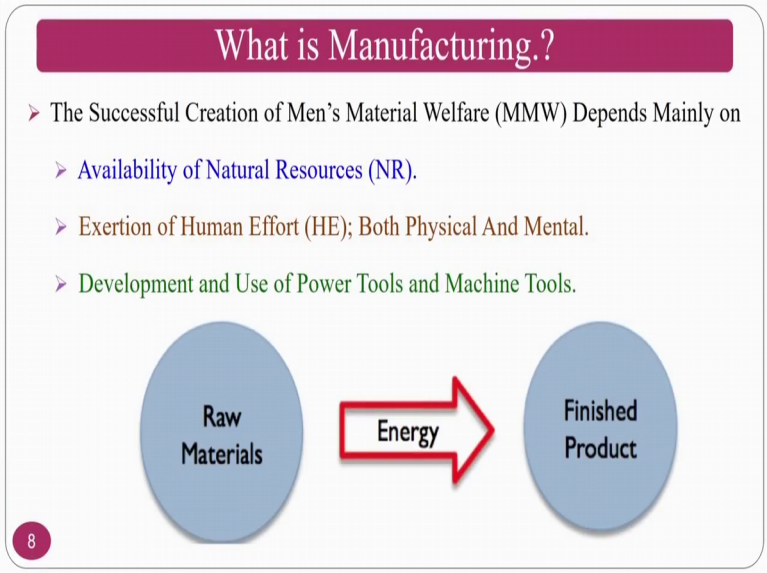
So, the first and foremost book that you can refer is principles of abrasive processes by M C Shaw. So, Professor V K Jain Micromanufacturing pPocess because advance abrasive finishing processes you can take from this particular course and elaboratively if you want to understand the mechanics, if you want to understand the what is in depth knowledge and all those if you want, you can go for Nanofinishing Science and Technology where you can study analytically and all those things.

As this course is a introductory course you will only understand how this process works and I will give you the glimpse of overview, I am not touching the mechanics and other things. So, I am not going to teach you any mathematics or something, I will touch some of the mathematics not in deep mathematics. In case if you want to understand so, you can see this particular book like Nanofinishing Science and Technology by professor VK Jain and Joseph Mc Geough is another book where you can study about the Advanced Methods in Machining. Professor G K Lal book I am following for the grinding operation and conventional machining and finishing operations, and Professor Ghosh and Maliks book in Manufacturing Science which gives you overview of abrasive machining and some of the finishing process also and Astakhov.

So, I am also teach in this particular course about grinding fluids and acknowledgical aspects of grinding fluids in all those things it also called as a cutting fluids, but same thing holds good for the single point cutting tool and multi point cutting tool cutting

fluids are same. So, we can use those cutting fluids as the metal working fluids in this particular course ok. Not only this course content is from these particular textbooks only, I have taken some of the research papers latest research papers and I have a compiled in this one. So, it content is not only the part of these particular books, you can also refer to the latest papers in this particular area.

(Refer Slide Time: 07:16)

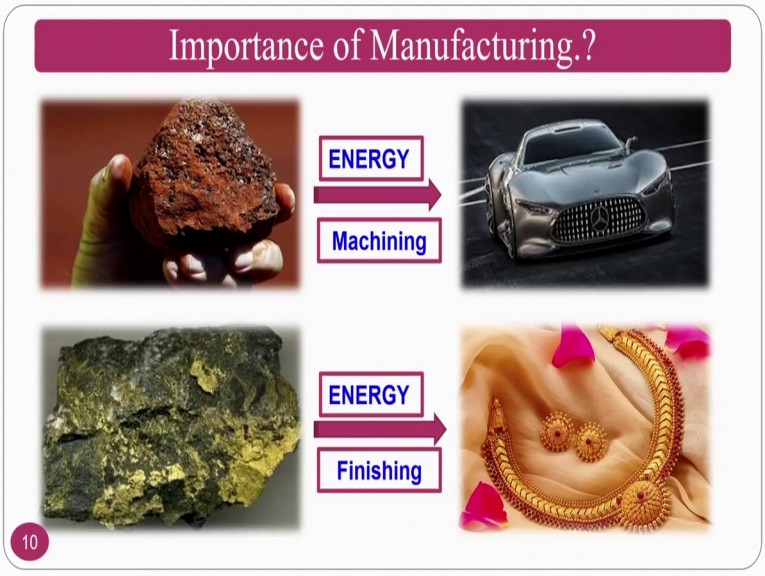


Coming to this introduction of this particular course which is a part of a manufacturing that is why I am going to talk about a little bit about the manufacturing. What is manufacturing? Successful creation of Men's Material Welfare depends mainly on the ability of natural resources, and exertion of human efforts both physically and mentally and development use of power tools and machine tools ok. So, in a broad view manufacturing is nothing, but conversion of raw materials using certain energy to a finished product. Assume that I have an a box side material, I want to make it a aluminium sheet for a car, I have to use certain external energy and then I have to prepare a final product.

(Refer Slide Time: 08:03)

This particular process of conversion of raw materials into the final product is nothing, but the manufacturing. Importance of manufacturing just you can see for the auspiciousness of this particular course I just gave you a glimpse this is a temple where they have fabricated using subtractive manufacturing processes like machining finishing and other things ok.

(Refer Slide Time: 08:18)



Importance of manufacturing I said we have the machining as well as finishing. So, I have a raw material that converting using machining and other processes not only

machining here there are other processes. So, you can fabricate a car structure and all those things. Another one finishing applications if you see the gold ore from that ornaments you can gold ornaments and other. This is a importance of the manufacturing and the manufacturing if the countries manufacturing is most developed; that means, that that country can become one of the super powers for example, China. China's manufacturing is so, good and we should aim as a Indians, we should also equally good compare to China so, that we can also become super powers. So, that means, that I request all the people that manufacturing is one of the good courses, which can makes India a good country. So, most of the manufacturing industries are there in India. So, you gain the knowledge and you work for those manufacturing companies and make India great ok.

(Refer Slide Time: 09:34)

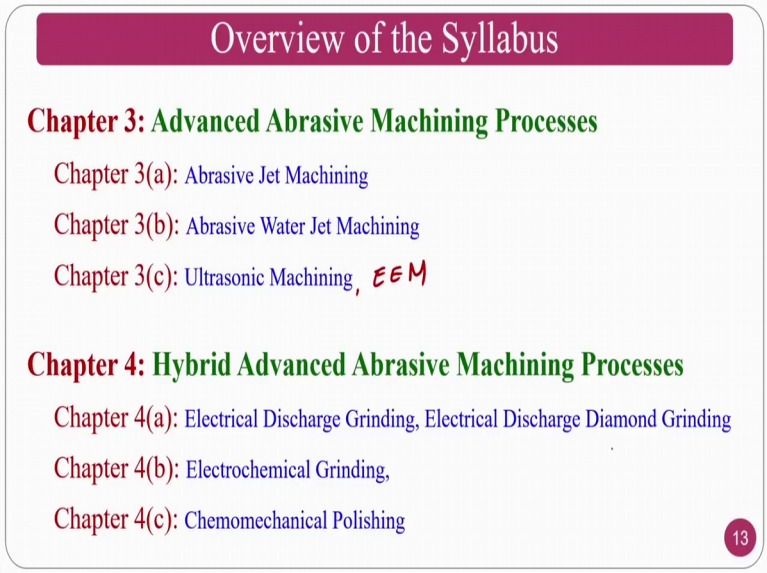
Coming to the syllabus of this course on introduction to abrasive machining and finishing processes, the overview of the syllabus chapter 1 deals with the introduction to abrasive particles classification of abrasive processes and the other things, second one I am dividing a particular chapter into 3 classes I am mentioning 3 classes, it may sometimes go beyond 3 classes or it may end in 2 classes itself ok.

So, for the particular plan is concerned I am having the 3 divisions. The first division is chapter 1 a Introduction to Abrasive Particles and Classification Abrasive Processes; second one is Grinding Process and its Classifications, Applications grinding fluids and

the other things, the third one you will see the Grinding Process, Tribological aspects, Grinding Fluids and sustainable grinding and other things.

Then comes to the conventional abrasive finishing processes like honing process, wire brushing process, lapping process, buffing, super finishing and other things we also study about what is surface integrity. The surface integrity refers to surface metallurgy process surface morphology, and many other practical conventional finishing processes we will study in this particular chapter 2. In chapter 3 we study advanced abrasive machining processes. So, I am talking about machining as well as finishing sometimes I am talking about machining sometimes I am talking about finishing. So, you will understand what is the difference in the later slides.

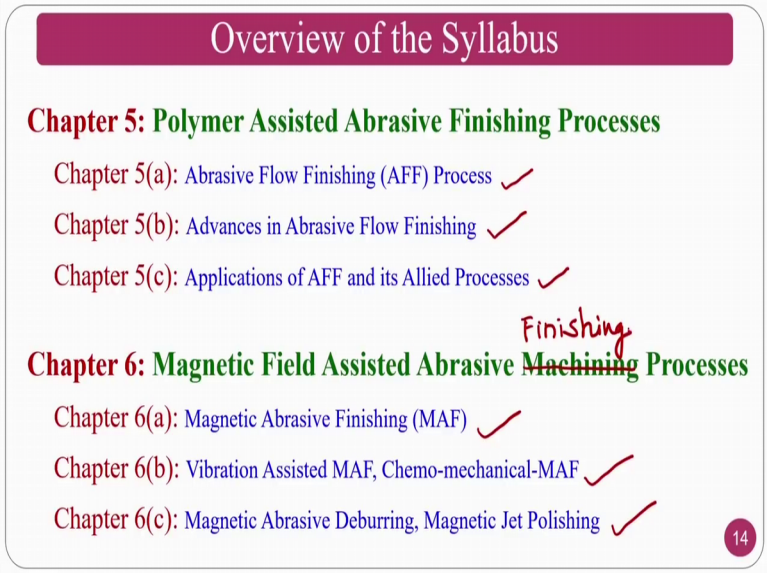
(Refer Slide Time: 11:09)



So, in the chapter 3 advanced abrasive machining processes we study about the abrasive jet machining, abrasive water jet machining ultrasonic machining followed by elastic emission machining.

In the chapter 4 we study about hybrid advanced abrasive machining processes such as electric discharge grinding, electric discharge diamond grinding, electrochemical grinding and chemo mechanical polishing these are the hybrid advanced abrasive machining process we will studying.

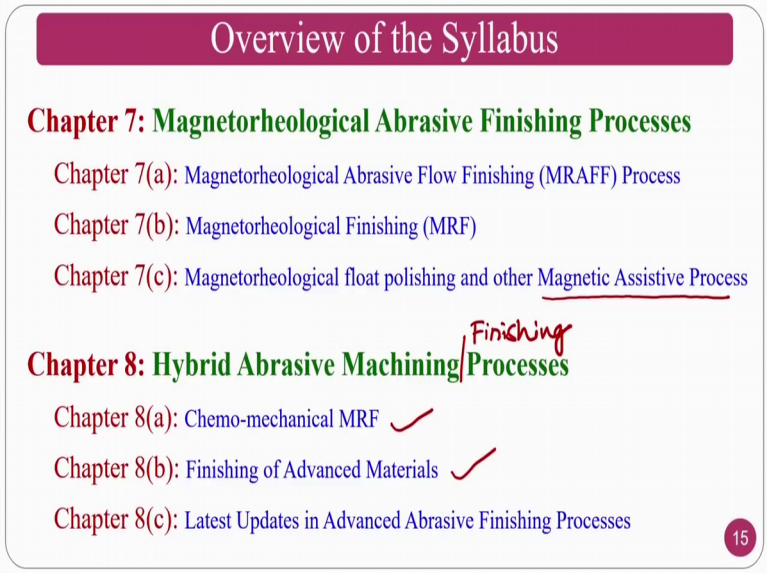
(Refer Slide Time: 11:37)



Then we go ahead with the latest trends in the abrasive finishing processes such as polymer assisted abrasive finishing process, where we will study about abrasive flow finishing process; advances in abrasive flow finishing process and applications and allied processes of abrasive flow finishing process. Some of the papers whenever you go through it is also mentioned as abrasive flow machining process also because in olden days people were using abrasive flow machining applications like abrasive flow, deburring process and other things, nowadays people are using for finishing that is why this is named as abrasive flow finishing process.

Then we will go for magnetic field assisted abrasive machining processes and finishing processes, that is called magnetic abrasive finishing, vibration assisted, magnetic abrasive finishing, chemo mechanical magnetic abrasive finishing, magnetic abrasive deburring magnetic jet polishing and other things here it is written machining and you can correct it as a finishing.

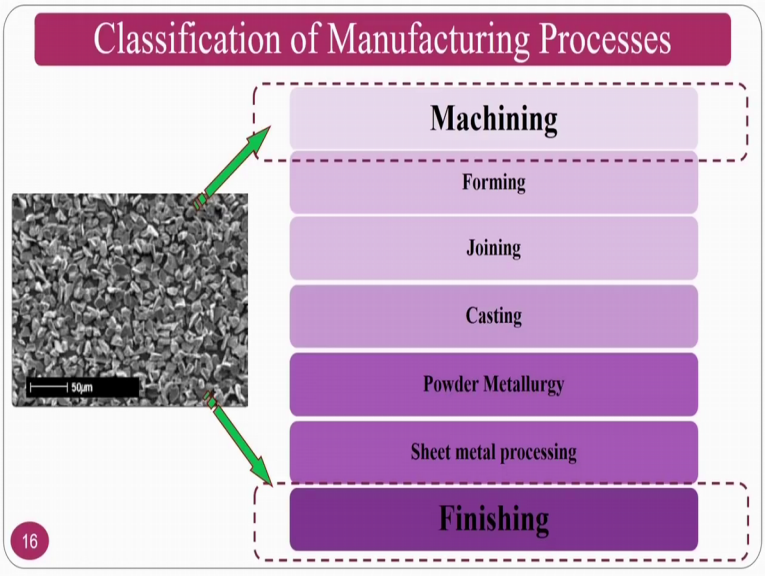
(Refer Slide Time: 12:43)



In the chapter 7 we go for Magnetorheological abrasive finishing processes, in a previous case normally you will have the particles. Here you will have magnetic slurry. So, you go through the magnetorheological abrasive flow finishing process magnetorheological finishing process, magnetorheological float polishing.

And other magnetorheological are magnetic abrasive finishing processes you will go through in chapter 7. In the chapter 8 you will go with hybrid abrasive machining processes are hybrid abrasive finishing processes. Chemo mechanical magnetorheological finishing process finishing of advanced materials like bio materials like implant materials finishing and other things and latest updates in abrasive finishing processes. Abrasive finishing processes that are there in the latest trends from the research papers I will explain to you.

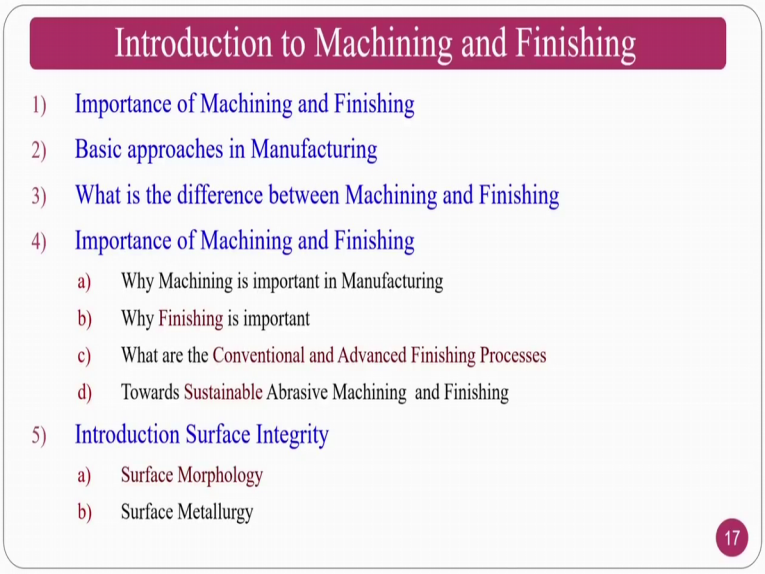
(Refer Slide Time: 13:39)



Coming to the classification of manufacturing processes, there are machining process forming process, joining process, casting process, powder metallurgy sheet metal processing and finishing processes. Among these so, machining and finishing processes are the ones that come under the abrasive processes.

Normally abrasives are used for machining as well as finishing, which are nothing, but the subtractive manufacturing processes.

(Refer Slide Time: 14:07)



Introduction to machining and finishing we will study about importance of machining and finishing. Basic approaches in manufacturing what are the difference between machining and finishing, and importance of machining and finishing why machining is important why finishing is important, what is the conventional and advanced finishing processes towards a sustainable and all those things this 0.4 we come across in the later cases, but 1 2 3 we will come across now and study of the surface integrity about surface morphology and metallurgy we will come in few classes later ok.

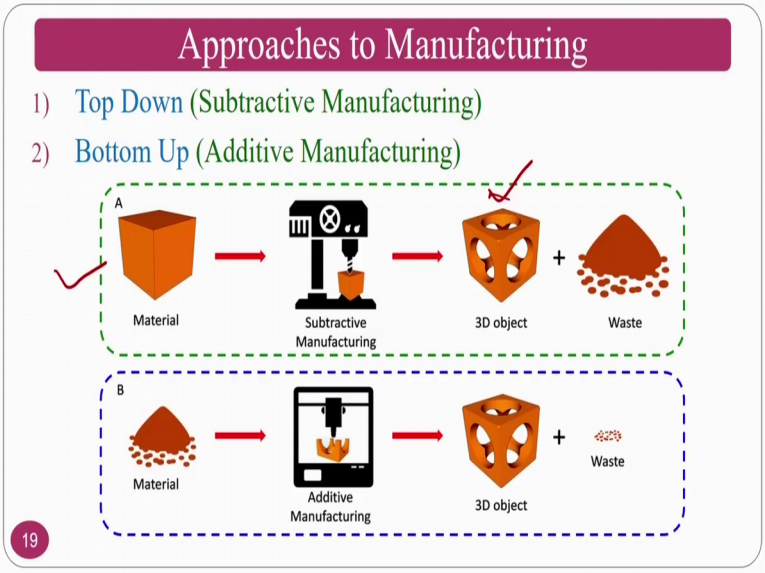
(Refer Slide Time: 14:43)

First and foremost why you have to study this particular course ok? So, that is a basic question that you will always have ok. So, this is a before and after you can see the surface here the welding is done, but you cannot directly use it, because the surface morphology is different at the same time surface metallurgy is different. In order to sell your product into the market, you need good aesthetic appeal, you need perfect tolerances and other things for that purpose you should go for machining and finishing of this particular things and you can clearly see here how the things are achieved. This is the beauty about abrasive machining and finishing processes if at all you want to go for advanced finishing of implants.

If at all you can see the knee surgery are totally replacement other things, if you see you need to go for a finishing of knee implant. This is the casted product and this is the finished product ok. Assume that you are going to keep the casted product directly inside

the knee what will happen? The surface roughness is very high metallurgical aspects are different. So, there will be a corrosion effect there will be a friction. So, lot of problems will come for that to overcome that you need to go for abrasive based machining and finishing processes. In the case 1 that is the pipe and welding and machining, you can go for the abrasive based grinding processes, but you cannot go for a knee implant. So, you have to go for abrasive finishing processes. So, in the case 1 you need abrasive machining processes in the case 2 you need to go for advanced abrasive finishing processes ok.

(Refer Slide Time: 16:40)

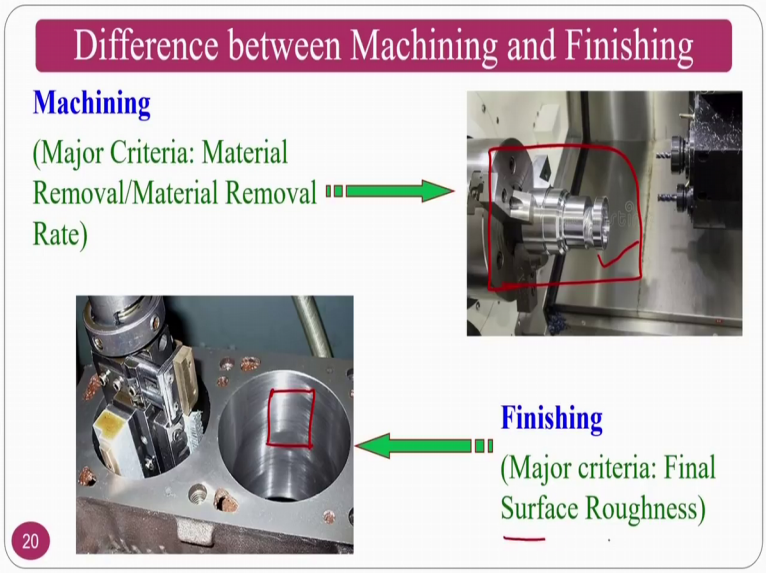


What are the 2 approaches in manufacturing normally there are top down approach. Top down approach means I have a material and I have to do the machining and take out the useful product that is called an object the tie bond this is called top down approach. I have a shape big shape out of which I have I want to make a small component, then I am doing a machining process I am doing a machining process to make a component that is called top down approach I am coming from top to the bottom ok. In the bottom up approach normally I have a powders and I am making a component like powder metallurgy is a bottom up approach, I have a powders I am going to compact it synthetic and I make a component in a first case I do the machining operation.

So, there is some problem in the top down approach such as material waste will be there in thumps up chips and all those things, and this particular course is followed top down

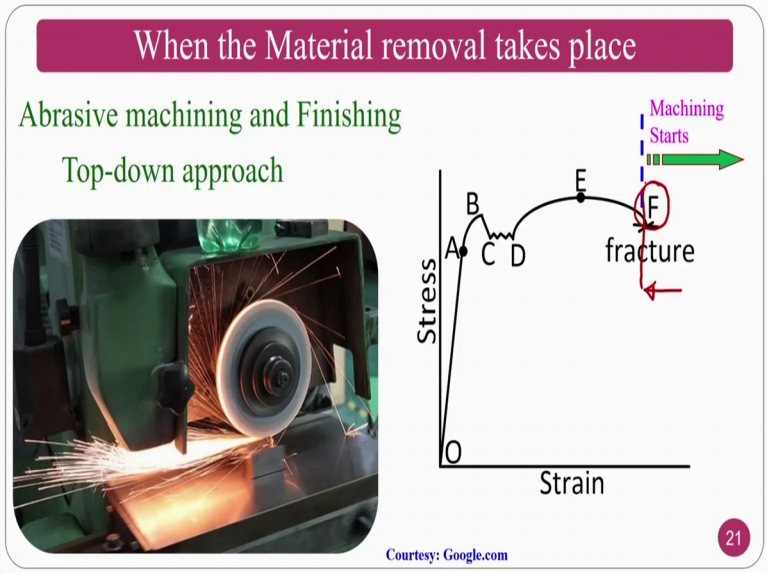
approach. And mostly people who are sitting may be a B Tech student or starting of M Tech students other students; you may not know what is a difference between in machining and a finishing some many of you may know ok. So, you should understand machining and finishing, because this particular course is abrasive machining as well as finishing. So, abrasives are constant and you are using for machining applications as well as finishing applications.

(Refer Slide Time: 18:22)



So, you should know what is a machining and what is a finishing. In a machining process if you see how much material I am removing from particularly this component is important that is my major criteria. In a finishing process my major criteria is not about how much material I am removing I am whether I got the particularly required surface finished or not that is the most. Even though I remove less material if I am getting a surface finish in a good way; that means, that surface roughness in a very low value; that means, that that is my finishing process ok. So, you think about what the surface roughness that I want so, that I can sell this particular product in the market. That if that is the criteria then you have to go for finishing process if your criteria is machining so, you just go for the material removal criteria ok. Assume that in a ten minutes time I want to remove 10 m m thickness. So, you have to go for machining process.

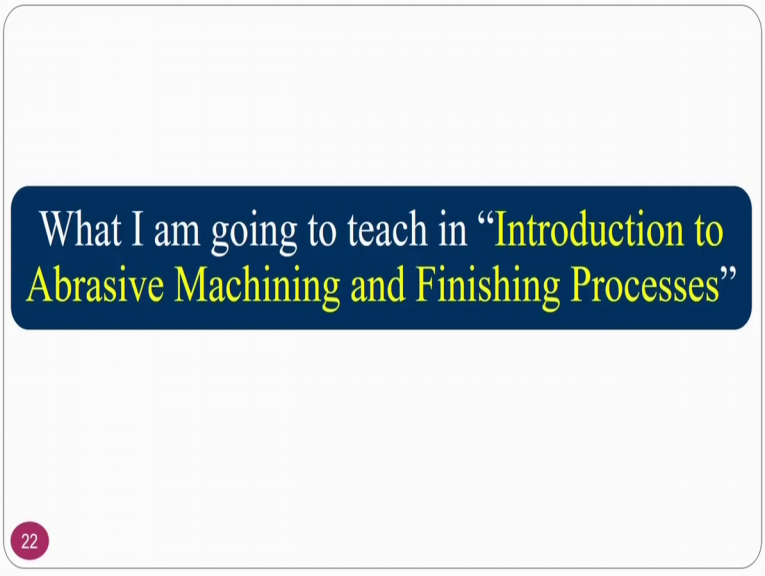
(Refer Slide Time: 19:22)



So, when the material removal takes place normally if you see the abrasive machining process, which is a top down approach in a grinding process or in a late process and other processes. Normally the machining takes place after the yielding bind; that means that, that is why these machining processes are called as severe plastic deformation processes ok. So, once the after this one only the material start sharing from the work piece ok.

So, we do not bother about much about the elastic limit and the other things, we directly go for failure. In this particular slide it is failure, but the thing for a machining people and a finishing people you need to remove the chip, that mean that you have to delaminate or you have to dislodge that particular chip from the surface; that means, you are fracturing or you are sharing; that means, that this particular thing we will start after this point F ok. So, do not think in a negative way that we are fracturing the particular component are it is not the fracturing we are taking out the chip from the work piece.

(Refer Slide Time: 20:38)



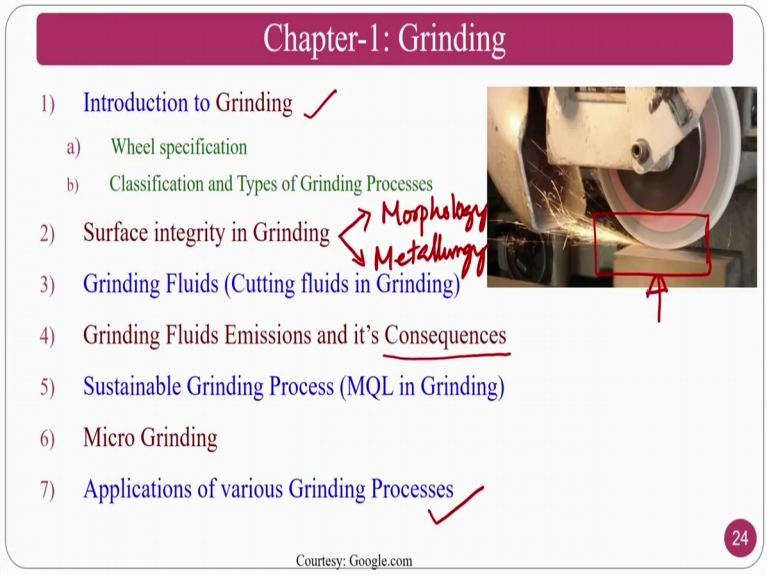
What I am going to teach in this particular course like an introduction to machining and finishing process, you have seen summary, but in an elaborative way how I am going to teach this particular course. This particular thing will help you whether you are really liking the course or whether really it will help you in your future or really you are going to gain the knowledge or something that you can decide by seeing this elaborative way of this particular course.

(Refer Slide Time: 21:06)

In the course 1 I have already taught you what you are going to study that is introduction to abrasive particles, bonded unbonded super abrasives when you call it a super abrasive. When you call it as a bonded abrasive, when you call it as a unbonded abrasive and other things you will study about this one then you go about conventional abrasive finishing processes and grinding other things. Among you know what is grinding and other conventional finishing processes, but you may not know what is a difference between bonded abrasive and unbonded abrasive; this is called unbonded abrasives and this is called bonded ok.

What about the abrasive particles individually you see in a market or if you want to purchase if it is individual particles; that means, called it is unbounded. Whenever you see a grinding wheel where vitrified bond rubber bond shellac bond is bonded; that means, that you know if you see a abrasive particle in a grinding wheel, that is called a bonded abrasive particle ok. So, this is a surface of a grinding wheel the last figure is a surface of a grinding wheel, but if you see unbonded these are the individual particles it is a individual particle.

(Refer Slide Time: 22:31)



So, chapter 1 also deals with grinding process. So, we study about the grinding wheel specification classification of grinding processes; what is a surface integrity; that means that how would you divide into 2 things that is surface metallurgy and surface morphology.

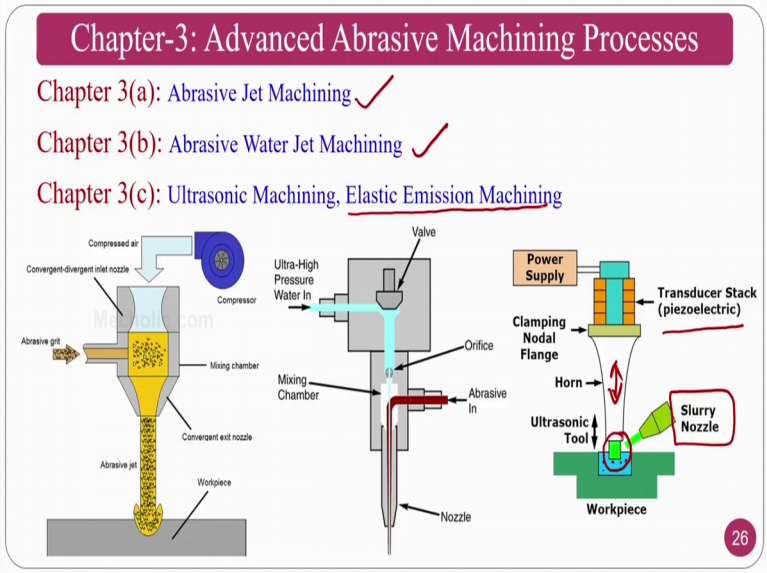
Grinding fluids which is a important one because this is an important whenever you go as an engineer to a certain company, people are using cutting fluids or the grinding fluids how this cutting fluid fall in the machining region or the grinding region or it will emit the emissions, how it is going to affect the particular operator and surrounding environmental (Refer Time: 23:26) sinks by studying about the grinding fluid emissions and its consequences, how to resolve this particular problems.

So, sustainable grinding and you also study about the micro grinding process when you call it as a micro grinding, when you call it as a macro grinding and applications of various grinding processes you will study. So, you can see here this is called as surface grinder and how material is removed you can see in this particular picture ok. This is how the surface is material is removed from the surface grinding process.

(Refer Slide Time: 24:02)

The conventional abrasive finishing processes you will study about the belt grinding process, honing process, wire brushing process you will also study about the lapping process. Normally lapping process is follows the 3 body abrasion, the grinding process will follow the 2 body abrasion and these are all things you will study in the tribological aspects of grinding. You will also study about latest things like a pitch polishing, what is pitch polishing and the other things. And you study about the sand blasting, micro blasting and vibratory finishing and drag finishing these are the common conventional finishing processes where you mass production or batch production is used.

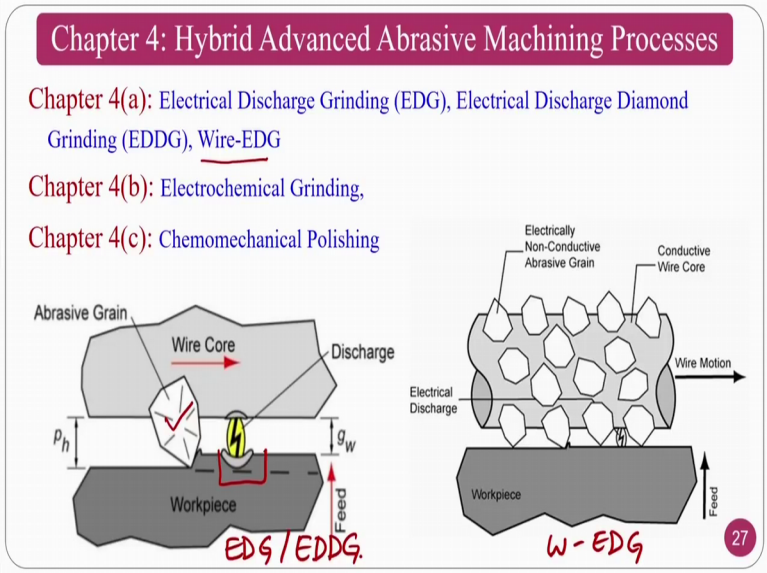
(Refer Slide Time: 24:46)



Coming to the advanced abrasive machining processes as you know, you are going to study about abrasive jet machining where abrasives are getting assistants from a compressed air, because the air is a carrier medium here and a abrasive particles will follow the path of injecting the air, but the air has a drawback that is it can diverge easily because of which the dimension that I want to get may be disrupted.

For that purpose people have gone for a advanced version that is called abrasive water jet machining, where you will get a highly compressed or pressurized water jet mixed with abrasive particles will; here compare to abrasive jet machining you are going to get better and narrow précised structure are whatever you want compared to abrasive jet machining here the divergence is slightly less. And we will also study about ultrasonic machining where piezoelectric transducer will give ultrasonic vibrations and you will have a abrasive slurry, which is passed from slurry nozzle where you will have a abrasive particles and this particular thing will reciprocate and you will get a whatever the shape is there convert shape you will generate. We will also study about elastic emission machining, which is one of the latest trends of machining and you can also call it as a finishing operation, because you can remove the material in a very very minute amount.

(Refer Slide Time: 26:20)

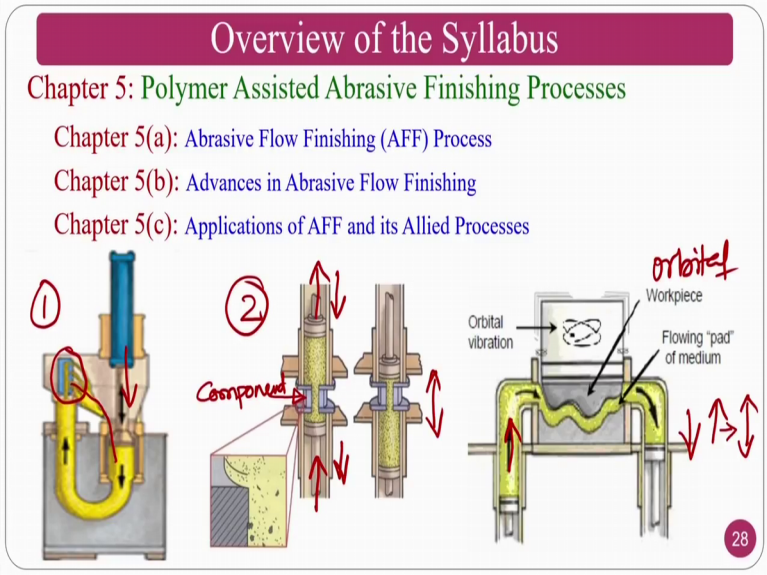


We will in the chapter 4 we study about advanced abrasive machining processes which are hybrid. Normally hybrid means you are clubbing one conventional machining process that is grinding process, you are mixing with some of the advanced machining process like e d m electrical discharge machining then these both are clubbed then it is called hybrid. So, one of the common process is electric discharge grinding where electric discharge machining and grinding process are clubbed each other, that is why this is called electric discharge grinding. So, in a electric discharge grinding you will have a discharge and you will have a machining with abrasive particle ok. So, discharge normally if at all I want to grind the ceramic particles like silicon carbide or alumina or bio ceramics like hydroxy appetite bio glass and all those things what you cannot do with a slightly higher abrasive particles for that purpose. You have to go for electrical discharge grinding process, where your discharge will help to make this particular process.

So, often this particular thing will become soft and your abrasive particle will remove it that is a beauty about this particular process. Similarly electric discharge diamond grinding where you will you are going to use diamond as abrasive particle, and there is another technology called wire EDG, that is called inset you here the people are clubbing the grinding with wire EDM and you can have a wire EDG process. Another process is electrochemical grinding similar technology where you club electrochemical machining with grinding process and chemo mechanical polishing or some of the papers also call it

as chemo mechanical planarization ok. So, whatever you are seeing here is wire EDG and whatever you are seeing here is EDG or electric discharge diamond grinding. If the abrasive particle is silicon carbide or alumina it is called EDG, if the abrasive particle is diamond then it is called as electric discharge diamond grinding.

(Refer Slide Time: 28:40)

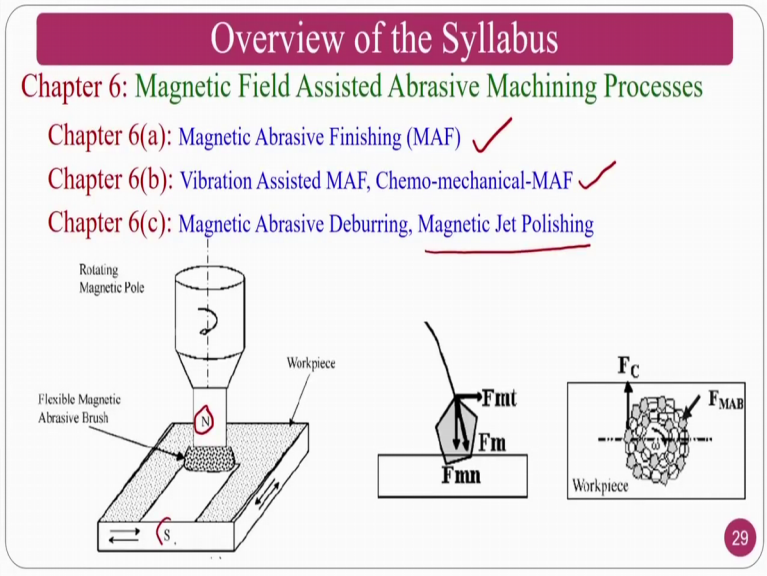


Then comes to the chapter 5 where you are going to study about polymer assisted abrasive finishing process, which is a good process for complex surface finishing under other things. There are 3 varieties one is one way abrasive process and 2 way abrasive process and orbital ok. So, in one way process you are just injecting the here the medium is most important, in this particular chapter you study about the machining as such thus machine structure, medium, tooling other things. In one way you are just pushing the medium that is polymer plus abrasives plus rheological additives, you are pushing in this direction and your component is here and you are finishing and again it is coming here. In a 2 way your component is here this is the component and you are reciprocating from 2 directions this direction it is goes whenever it is upper direction, this also goes up whenever this goes down this also goes down ok. So, this is called 2 way and orbital you will have a orbital motion where if at all I want to finish the complex blind holes other things you can do by orbital finishing, but here also medium is reciprocated. So, medium will come again this pester will move up. So, normally on an average if you club this motions, you will have this particular motion similarly in the 2 way also you will have a this particular motion. It give it goes up and comes down goes up and comes down in 2

way, similarly in the orbital also magnetic field which is another field of interest to many of the masters.

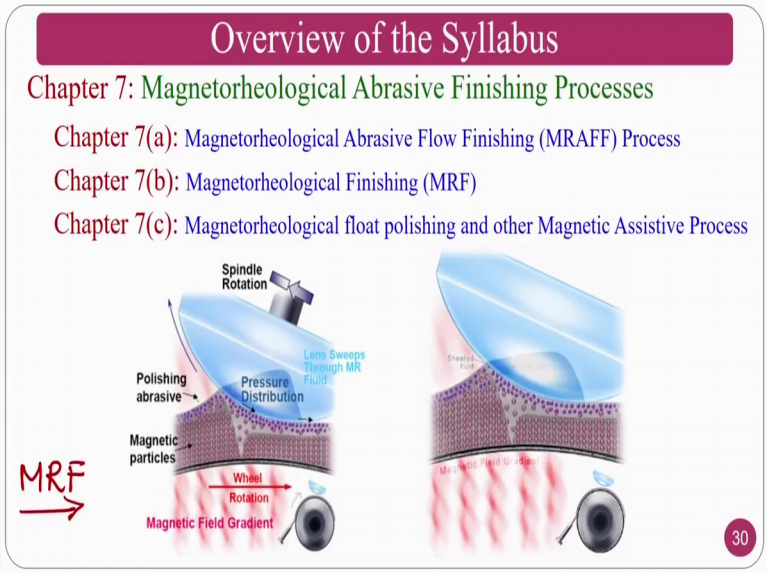
And PHD students along with the polymer rheology, you can also study about magnetorheological fluids. Here magnetic abrasive finishing, vibration assisted MAF and chemo mechanical magnetic abrasive finishing, magnetic abrasive deburring and magnetic jet polishing other things you will study in this particular course.

(Refer Slide Time: 30:57)



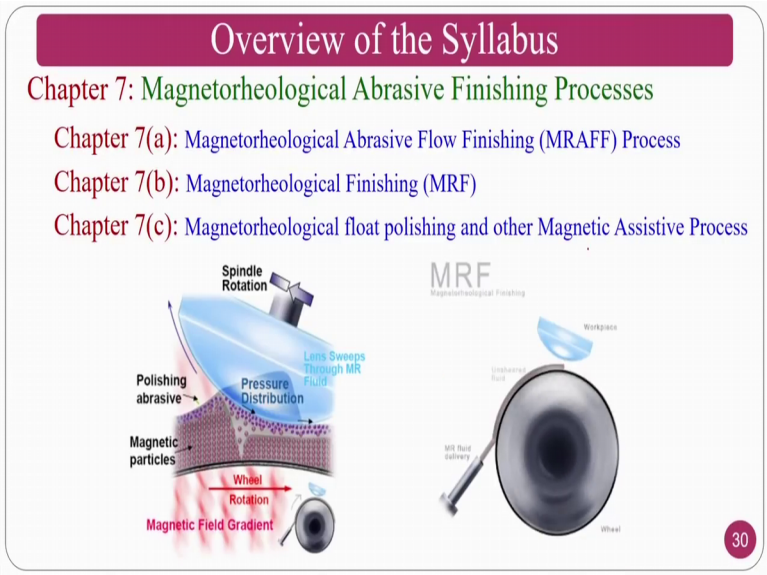
You can see here this is a north pole and this is a south pole, in between you will form a magnetic brush where magnetic brush consist of carbonyl iron particles, which are iron particles basically which in a pure form at the same time abrasive particles. Whenever you have an electromagnetic field this particles will form a chain, CIP particles form a chain that is carbonyl iron particles will form a chain wherein abrasive particles will held. At the same time some of the people will also use bonded abrasives where they will sinter the abrasive particles on to an iron particle that is what you can see in this particular things these are all one type of bonded abrasive particles.

(Refer Slide Time: 31:41)



In this chapter 7 you will study about magnetorheological fluids where it is slurry basically. So, these fluids are used for sophisticated applications like contact lens polishing and other things. So, magnetorheological abrasive flow finishing process magnetorheological finishing process magnetorheological float polishing and magnetic assistive other process we will see.

(Refer Slide Time: 32:04)

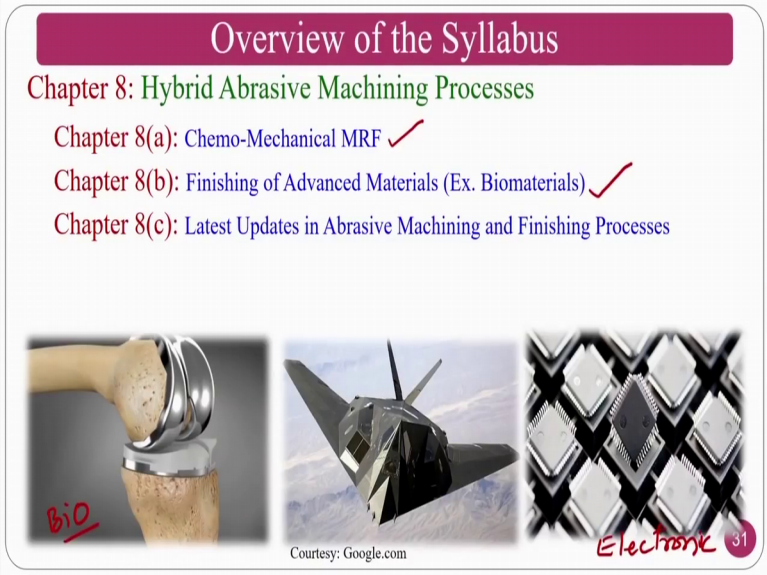


Whatever you are seeing here is MRF that is called magnetorheological finishing process, where you can also see the video how the magnetorheological finishing process

works. Whenever magnetic fluid is put on to the disk where the electromagnetic field is there, it forms a chain.

And then you can put the component whatever the in particularly this work piece you can press against the fluid, since it is a fluid whenever it comes to the exposure or whenever it near to the electromagnetic field, it forms the stiff fluid and the polishing will takes place. The stiffness is a function of your composition and the field strength that is magnetic field strength. At last and the last chapter we will study about hybrid abrasive machining processes and finishing processes; one is a chemo mechanical MRF we will study normally.

(Refer Slide Time: 33:00)



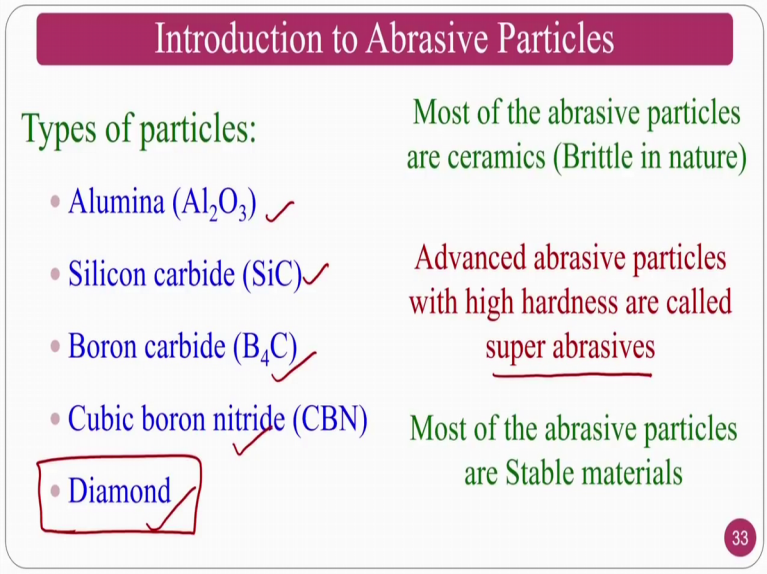
How the chemical aspects of this particular process also come into picture and along with the magnetorheological finishing process finishing of advanced materials like biomaterials, electronic materials, and aerospace materials wherever required normally the complex surfaces of knee, implant which is a biomaterial you have to finish.

And you the components like which are used in flight or jets which are used in the other aerospace applications component and defence applications, and silicon based electronic things also components also we will see how to finish and latest updates, if possible time is there and if the what are the latest updates in this particular abrasive machining as well as finishing and we will summarize this particular course.

So, this is about the complete elaborative way, how I am going to teach or how the lectures are planned ok. Sometimes it may go plus or minus some things because this is what the exact plan I am sticking for this particular course, and it may slightly vary in some of the cases it may go for 4 lectures some of the cases it may go for 2 lectures, mostly I will try to do my best to give you a better knowledge in a systematic way

Now, I am moving to the introduction to the abrasive particles because this particular course is completely deals with abrasive particles. So, you should know what is an abrasive particle, how you can measure the size and shape and other things.

(Refer Slide Time: 34:49)

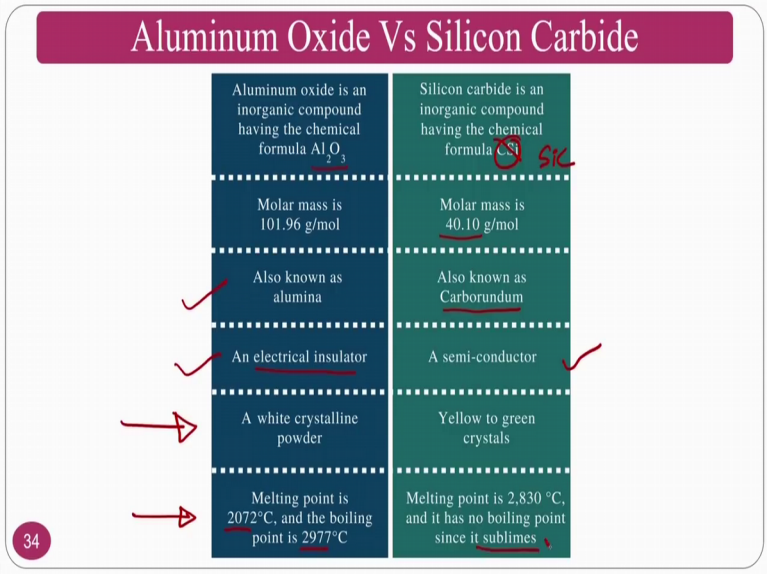


So, various abrasive particles commonly available across the globe and in particularly India you can go for alumina, silicon carbide, boron carbide and cubic boron nitride particles and diamond particles ok. So, hardest particles are diamond particles the most of the abrasive particles are ceramics; that means, that they are brittle in nature ok. If you just press it with a mechanical force or it will fracture assume that it is like a glass. If with some external force is applied it will fracture into pieces such that it is called a ceramic particle.

So, these particles are brittle in nature, this advanced abrasive finishing process is if you require to finish in a nano level normally you will go for a high hardness abrasive particles such as diamond particles and other particles, these are particles are called as super abrasive particles. Most of the abrasive particles are stable materials normally Al 2

O 3 or SiC these are all stable they have they do not have free electrons in the outer shells most in a most cases. So, these are more stable. So, chemically reacting is very less compared to metals.

(Refer Slide Time: 36:12)



So, normally 2 abrasive particles are used in most of the machining and finishing applications that is called alumina or aluminium oxide and another one is silicon carbide. If you see the difference between these 2 particles, aluminium oxide or alumina is inorganic compound which a chemical formula A l 2 O 3 and normally this is called as SiC silicon carbide ok.

So, the molar mass is 101.96 gram per mole and another one molar mass is for 3.1 gram per molar mass this is also called as alumina and this also called as carborundum silicon carbide is called as carborundum. Alumina is a electrical insulator and it is a semi-conductor silicon carbide is a semiconductor normally it also very less conductivity will be there that is why many cases some of the people are trying for electric discharge machining of silicon carbide and other things. And this is white crystalline powder silicon carbide is yellow to green crystals you will get and the melting point and boiling point of this alumina is 2072 and 2977 respectively, in the melting point of silicon carbide is 2 eight 3 zero centigrade it do not have the boiling point it directly sublimes.

(Refer Slide Time: 37:37)

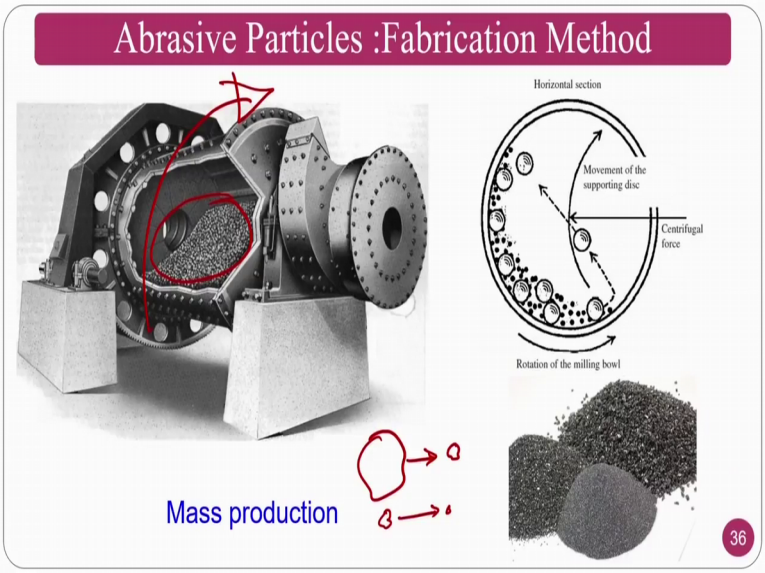
Abrasive particles normally this abrasive particles are fabricated by many ways, some of the common ways are one of the most common way of fabricating the abrasive particles is by ball milling operation. Whatever you are seeing is a planetary ball milling process and where you have a balls, these are the balls that are used and these balls are placed inside this things you can see here how the balls are placed inside this one then you put the lid on top of it, and you close this one like this then this particular things are placed here.

So, you can see here in the 4 things are there, just you place it then you close a lid like this now the machine whenever before going to operation looks like this, you can give 002C your input conditions here and you can do make the particles ok. Assume that I am getting a very course particles or big particles as I said these are the ceramic particles whenever you place this inside and assume that this is the particles that I want and I want to convert this particles to this particles.

Assume that this one is my particle and I want to convert into 2, I place these particles inside and I will place along with the balls and I will close the lid then I place in a plot ball milling and I will rotate it. So, it will rotate with high speeds these balls are much harder balls. So, this will hit the particles since it is a ceramic particle brittle fracture will takes place and in a go of five hours to 8 hours sometimes people go for milling into 24 hours also.

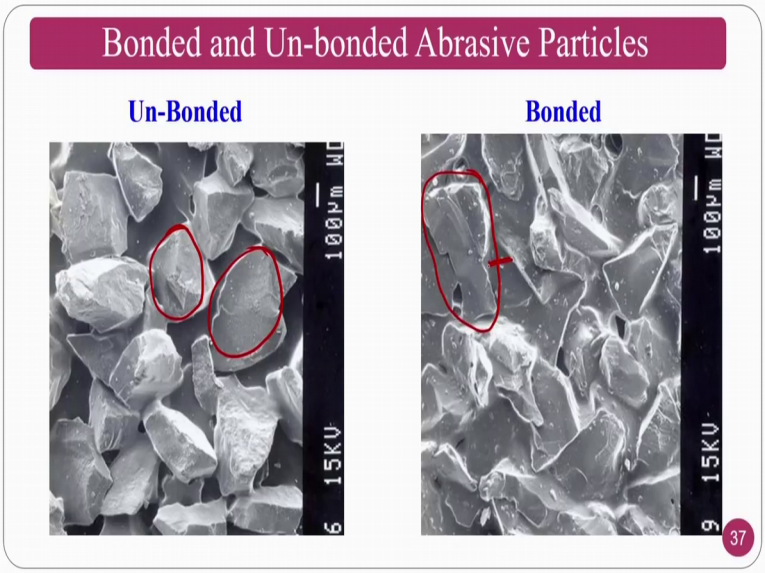
So, you can get fine powders ok. So, similarly if at all I want have the big particles, I want to make it small you can go for the big commercially used methods.

(Refer Slide Time: 39:39)



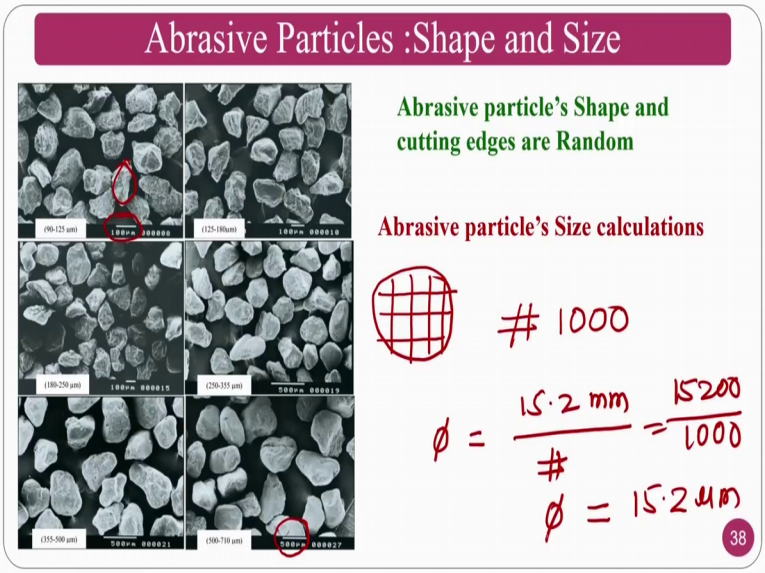
Assume that I want to make a small particles you can go for mass production about this type of things and where you can see the balls are there, and you place the abrasive particles whatever you require then you will get the particles. Similarly you can convert big particles like this particles to this particles or this particles to this particulars you can do particularly by this; one just what you have to do is you have to place inside this chamber and once you close it you rotate at very high speed you sometimes people also give the vibrations to it so, that we will get much better particles uniform size and other things.

(Refer Slide Time: 40:24)



What is the difference between bonded abrasives and unbonded abrasives? If you see here the abrasive particles are individual entities, this is called unbonded abrasives as I said in the earlier slides also these are called bonded abrasives. You can see the periphery of the abrasive particles, it is completely bonded with a bonding material.

(Refer Slide Time: 40:43)

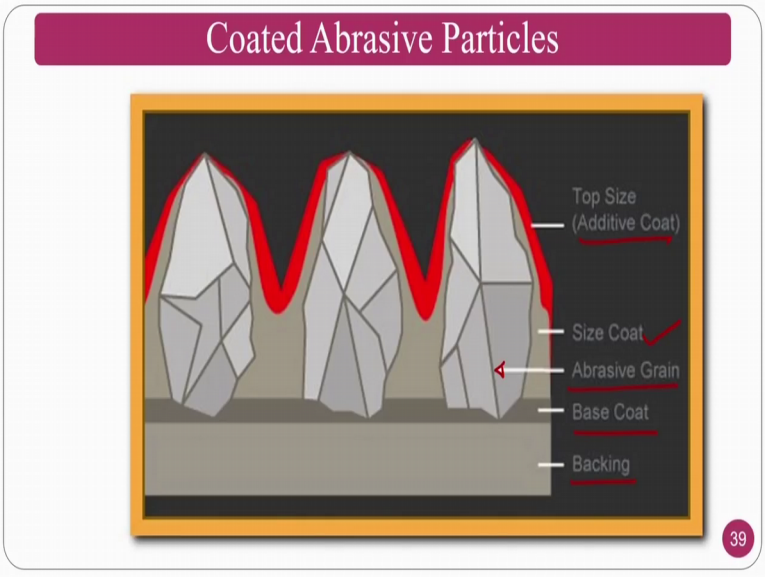


Shape and size normally you can see the size from course to fine to super fine, normally abrasive particles are divided into 4 segments course medium fine super fine ok. So, if you see here these are the course particles and whenever it comes to a big size,then it

will have the bigger size particles also. So, the scale is different people should note what is a scale size here, because the particles are looking approximately same, but the scale size is different ok. So, you should be very careful about the scanning electron microscopy is scales.

So, how do you calculate abrasive particle size? Normally abrasive particle size whenever particular person want to purchase a particular size you always mention the mess size MES size means member of sews. Sews means normally you know no our mothers normally sew the the wheat flour and the other things. So, you will have a sew like this ok this is called as sew. So, normally this represent in terms of mes size. So, assume that you are going to measure the mes size ordered mes size 100 so, how do you calculate particle size equal into 15.2 m m by the mes number ok. In this particular case if you convert into microns it will become 15 1200 divided by thousand. So, approximately it comes around or exactly you can say micrometers. The particle size are average diameter of this particular particle is 15.2 this is the how you measure or how do you calculate particularly the size of a abrasive particle once you know the abrasive particles, you have the stables, when you call. It as a course particle when you call it as a fine particle, when you call it as a super fine particle and other things you can understand if the particle size is very small then it can call it as a super fine particles ok.

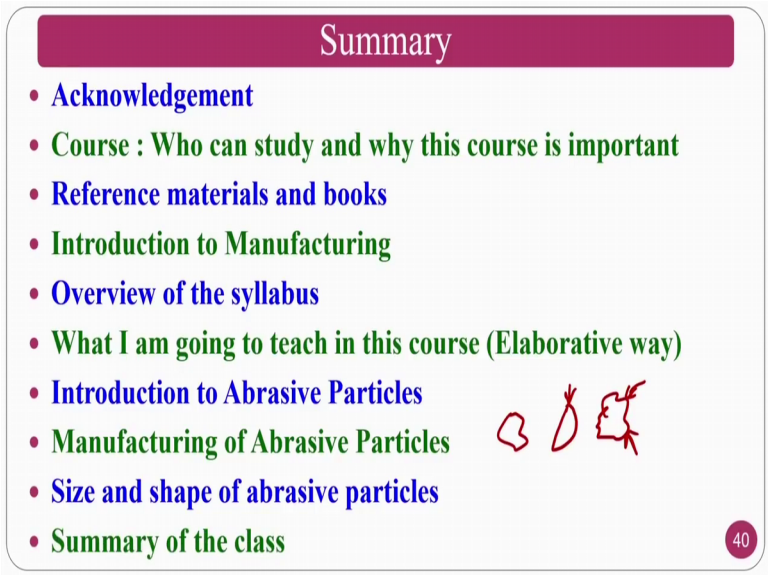
(Refer Slide Time: 43:01)



There are varieties of abrasive particles and some of the applications required coated abrasive particles ok. So, people also use as a coated abrasive particles now normally you can see the abrasive, additive coating is there at the same time size coating is there abrasive grain particle, you can see this is the abrasive grain and the base coating is done and backing material.

Normally whenever if at all I want to make super abrasive particles you can go for coating very hard materials and abrasive particles sometimes people want to make soft coatings also on abrasive ok. If at all people want to go for soft coating or hard coating, you can go and coat this particular things. Some of the people also use as functionalizes whenever you are going to talk about the magnetorheological finishing process or polymer rheological abrasive finishing processes, these are the abrasive flow finishing processes these particular processes if at all you need perfect bonding between the rheological added tools at the same time with the abrasive particles, that bonding strength you can vary by functionalizers. So, you can coat or you just you can in a ball milling operation you just put the functionalizer and you can mix it or ultrasonication or you can use many techniques, to make it functionalize or you can coat it these are called as a coated abrasive particles.

(Refer Slide Time: 44:35)



Particularly summary of this particular course.

Particularly summary of this particular course, I have acknowledged to the many of the people from the CEP head Professor Khijwania to Professor Narayan Reddy who helped me technically and professor khijwania helps in terms of providing the facilities and providing the staff I am thankful to him. And Professor Narayan Reddy who is very good friend of me and he is no more he gave me a lot of knowledge from the technically point of view, I always thankful for Professor Narayan Reddy and course who study and why you have to study to whom it will be helpful. I have already explained and a reference materials I am again telling you this particular course not only depend on the books or the reference books or the reference materials. I am also following some of the latest research papers.

So, clearly if you can understand you can easily answer the assignments as well as you can easily answer the examinations to understand the questions. To understand the assignments you please understand the course and strictly follow the course. So, that you can easily gain the knowledge as well as the marks introduction to manufacturing overview of the syllabus in a nutshell as well as elaborative way, how and what I am going to teach an introduction to abrasive particles manufacturing of abrasive particles.

How the abrasive particles are fabricated these are the materials that we are going to use in a grinding process lapping process super finishing, abrasive flow, finishing magnetorheological finishing anywhere my abrasive particle is a main particle or the main element of this particular course.

So, I have explained you about the abrasive particles and size and shape, the size and shape size is random normally you can save it, but the shape normally the cutting edges are randomly over (Refer Time: 46:55) and the shape is also random. A abrasive particle may be like this another abrasive particles may be like this another abrasive particles may be like this. So, the shape is random and the same time you can see the cutting edges this particular cutting edge this particular cutting edge and this particular cutting edge cutting edges are also random.

So, if randomness increases the surface roughness will give you better and better; that means that surface roughness value will be low and low. And at this last I am summarizing this particular class thank you for your kind attention in this particular class

and in a elaborative way, about this particular course and content we will come up and hope you gain a great knowledge from this course.

Thank you.