Introduction to Composites
Prof. Nachiketa Tiwari
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 02
Composite Materials and its Applications

Hello welcome again to introduction to composites MOOC course, we will be continuing our discussion which we initiated in the first class of this course which was yesterday. What we plan to do today is continue that discussion and also share with you some examples which we may think they are composites, but in reality they necessarily are not and the other thing I plan to do today is give some examples of actual applications where composites are used and then finally, if we have time we may start discussing how are composites classified you know in different categories.

So, that is what we plan to do today. So, let us start our discussion. So, what we had discussed earlier were some examples of composites, now we will look at certain examples which are not composites, so but before we do that let us look at the definition of composites once again.

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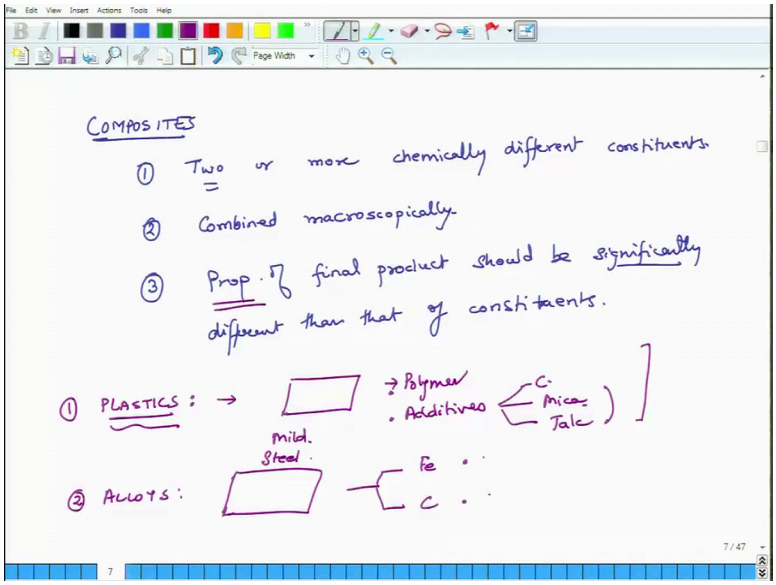

So, what does it require? So, composites the first thing is that it should have two or more chemically different, a composite should have two or more chemically different constituents this is the first requirement. Second thing is they should be combined

macroscopically you do not have to combine them at a microscopic level, if they are combined in microscopic level we do not call them composites because their mechanics have will be is developed in some other ways. The third thing is so yesterday I had said that it should yield a useful material, now what that implies is that the properties of the final product it should be significantly different than that of constituents if it is same as the constituents then there is no new useful material right.

So, another way to you know say that it should yield a useful new useful material is that properties of final product should be significantly different than that of constituents. So, these are the three requirements first one; we should have two or more different chemical material chemically different materials second; when we mix them we should be able to separate the different materials at a macroscopic level third; the properties of the final product should be significantly different than the properties of the original materials these are the three things. Now with these things let us look at some examples of materials, let us look at some general plastics now let us look at some plastics.

Now, for an example of this will be polyester now polyester chemically is a single material, but if you go and buy lot of regular plastics what you will get is not only just one single material, but if you do the chemical analysis of it if you buy a piece of plastic from the material from the market it may have some polymer, it may also have some additives and for example; one additive could be carbon to make sure that it has some blackish color lot of times.

They put some carbon in it and carbon makes the material resistant to sunlight and things like that or it may have some other material additives like mica or talc and things like that and sometimes they add these materials to improve some of the characteristics of the material or in other cases they just add it to provide to fill up the volume because they want to use less of polymer and they still want to fill up the volume, so they use put mica talc things like that. Now so if you buy a piece of plastic in the market you will say that this is one chemically different material and then additives are still chemically different and when you mixture mix them they are actually being mixed at macroscopic level. So, they should be composites.

But the answer is still no they are not composites, because when you evaluate their properties for instance you evaluate the tensile modulus young's modulus of this plastic

which has a lot of additives you may find that it is young's modulus is still very similar to that of the pure polymer. So, in that for that reason a lot of these plastics even though they are mixtures of two different chemical constituents they are combined microscopically, but because they do not meet the third condition they are not composites, another example would be; alloys for instance if you have a piece of mild steel by enlarge mild steel has two components; one is iron and another is carbon.

And if you mix them in the right proportion the properties of the mild steel properties of mild steel for instance it is tensile strength will be significantly different than the tensile strength of iron and also the tensile strength of carbon it will be significantly different. So, you have two different chemical constituents iron and carbon, you are mixing them and you are getting the new product called mild steel and the some of the properties are significantly different than that of iron and that of carbon, but still we do not call these types of alloys as composites, because they are not combined at a macroscopic level because when you make a cross section and view these things in the microscope you will not see two different materials.

You have to really go at a very deep level and there you will see some changes in the crystal structure or grain at the granular structure that is the level at which you will see different phases of the material, but at a macroscopic level you will not observe any differences you know it will be one whole homogeneous product material. So, for that reason these alloys also we cannot classify them as composites and for the same reason there are a lot of metals which have impurities and for the same reason they are also not classified as composites.

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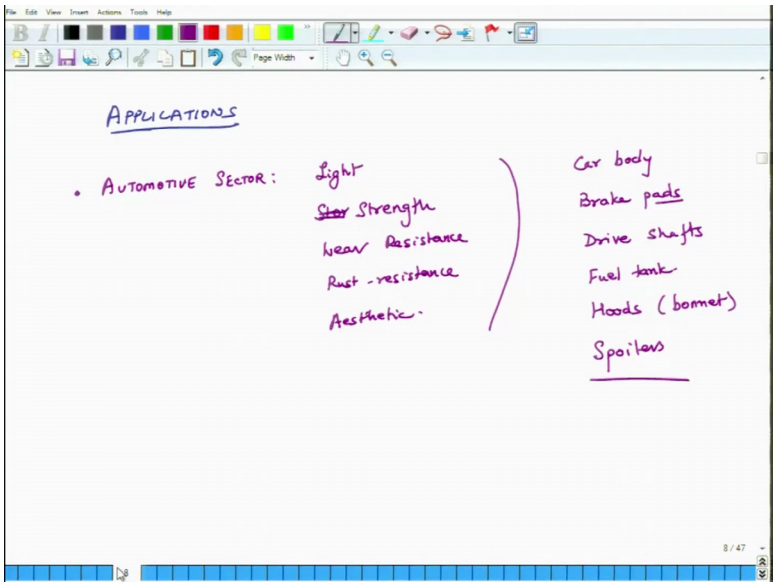

Next we will look at some of the applications of composites applications. So, let us start so for instance composites are very heavily used in automotive industry in automotive sector a very heavily used in automotive sector why do we use in automotive sector? Lot of times we make them we use them to make things light and as we go detail deep into this course we will see why some of the composites give because that advantage. So, we make.

So, to provide like to reduce mass of the object without making things weaker, sometimes we use these to provide strength, sometimes we use the same thing these composites to provide wear resistance, rust resistance and sometimes we also make them use them to provide aesthetics to make things look pretty for instance a lot of times some outside skins of cars maybe having a Kevlar coating.

You know because it has a yellowish, brownish hue and then you will see the fiber so it gives a very fancy look or sometimes graphite fibers are used to make the skin of the of cars and things like that. So, that it looks different and prettier. And in this context where do we use this? we use these composites for car body you make them used in brake pads in brake pads they are used to provide wear resistance.

If you have a car in your home and you open it is clutch or the brake pad either of those, you will see that some parts are made from composites use them in seats no drive shafts here the purpose is to make things lighter fuel tank, again here the purpose is to make

things lighter and also composites or some composites are highly corrosion resistant, so that is their hoods or what you call bonnet same thing spoilers, so and then there are several other places. So, this is where why we use composites in cars and trucks and SUV's and things like that.

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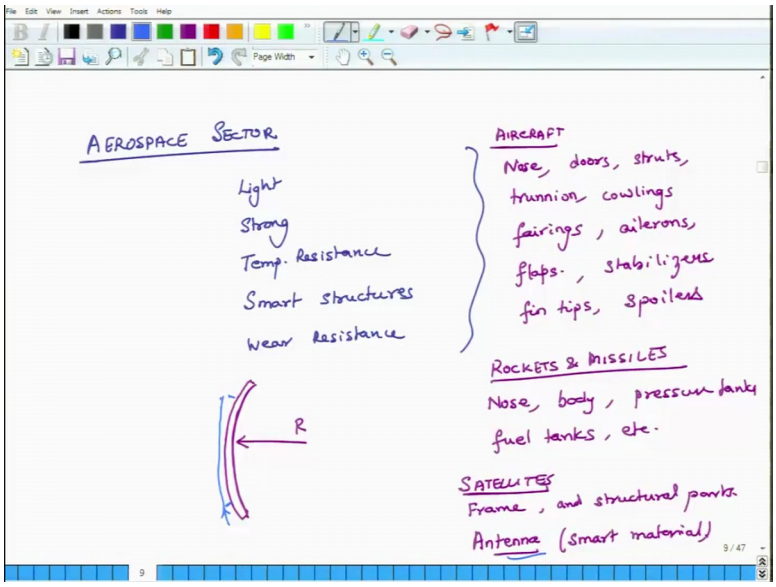

Another big area where we use composites is the aerospace sector. Again why do we use it? to make things light to make things strong and light is really important in aerospace sector because every kilogram you reduce the weight of flying object things become easier for you in terms of design and reliability and everything cost. A lot of times in aerospace you use these to provide temperature resistance, then you have where you want to develop smart structures and we will give examples of some of these cases and then of course, wear resistance.

So, let us look at some of the applications. So, one application is aircraft, so where do we use in the aircraft? In the nose when a plane flies it has a nose and there is a lot of friction between air and the nose so things can become really hot and also if there is a lot of wear resistance friction so you want things to be wear resistant and also absorb a lot of temperature and you do not want to increase the mass.

So, there are some special composites may be used to handle these things, they are used indoors they are using a structural member called struts. So, please go back and check in your mechanics book what is a struts? It is a structural member it takes a lot of load. So,

there you want it to take a lot of load be strong, but still be light so that is there. In trunnion these are again structural members; cowlings, fairings these are all aircraft parts ailerons, flaps in some are in the wings there are flaps which open and close to control the aircraft and it is speed and direction. So, the then you have in stabilizers, fin tips, spoilers and so on and so forth.

But I said aerospace sector, so another part of aerospace sector is rockets and missiles, they are also composites are used and actually in these components various highly engineered composites are used. So, a lot of these composites are used in the nose and in the nose the requirement the biggest requirement is temperature resistance, because when a missile enters the atmosphere so it goes up and while it is going up it gains speed and it slowly reaches very high so there is not a lot of air and that is where it picks up a lot of speed and then it has to come and hit some other place on earth so it comes down and when it enters the atmosphere it becomes really hot, because it is velocity is very high and the nose has to be able to bear a lot of temperature, so you make them from some specific composites and that is used in the nose.

Then you use them in the body of the rockets and missiles because you want to make things lighter and then in pressure tanks again for purpose of reducing mass, so pressure tanks and then in fuel tanks etcetera. And then the third big area where composites are used in aerospace sector are in satellites and they are the requirements are in some cases similar, but there may be some special requirements we will talk about that. So, in some cases for instance in the frame is the one which takes all the load of the satellite, so it has to be strong but it still has to be light so that is why a lot of times composites are used their frame and other structural parts.

But then they are also used in antenna and what happens in antenna? A lot of times they use some smart materials in antenna and that is where composites come in really handy. Lot of times what is required is suppose if this is an antenna and you want to control this radius of curvature of the antenna, because if you increase the radius of curvature you get information from larger area, the focal point may also change.

So for some reason you want to control the radius of curvature based on the location and what you want and it is sitting in air or in the space and these this antenna may be made of some especially engineered composite material and it may also have some smart

material wire, may be a SMA wire things like that and by changing the voltage in this wire you may be able to change the shape of the antenna, so that is why it is called a smart structure you can control. So, these types of special composites are used in antenna, so this is another big area where high tech composites are used.

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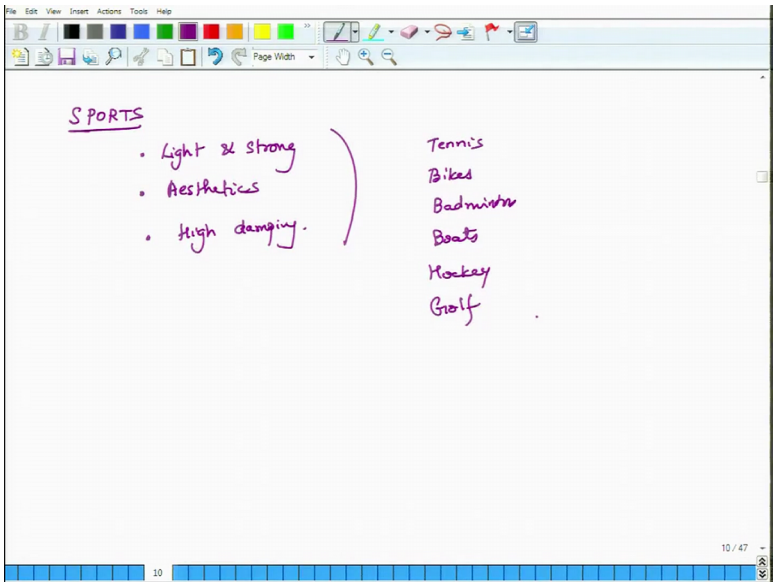

Then we see that a lot of times composites are very frequently used in sports and why do we use them in sports? Because they are light for instance a tennis racket you want it to you do not want it to be very heavy. But you do want that it should be strong right? So you want it to be the light as well as strong.

A lot of times you also use these composites for aesthetics to make things visually appealing and in other cases you want to make sure that it has high damping. So, for all these reasons people use them in tennis, I mean there are lots and lots of applications bikes, badminton rackets, boards, hockey, golf, motorcycles and so on and so forth, they are also used in transportation, are used in transportation and infrastructure.

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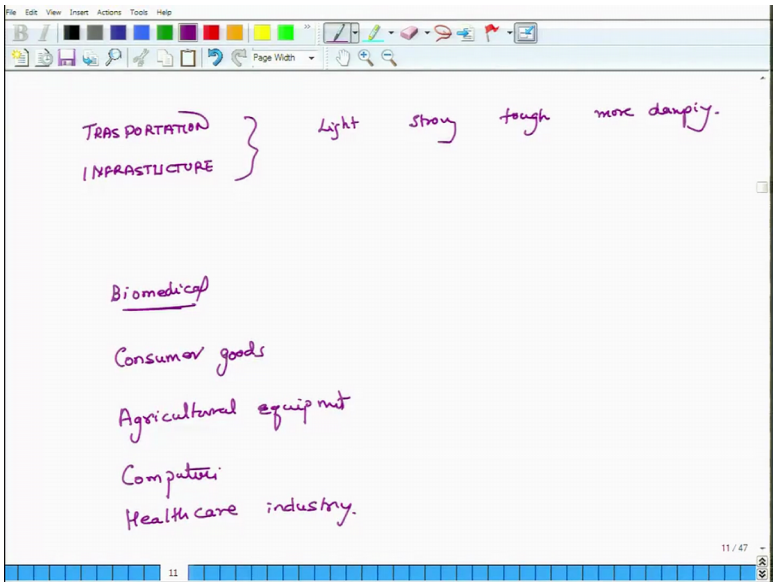

So, again the purpose is to make things light, strong, tough and more damping. And for these reasons lot of times these composites are used in railway coaches, they are used in bridges, they are used in ships and boats, they are used in dams they are used in bodies of trucks, they are used in recreational vehicles SUV'S and so on and so forth ok, so this is another big area.

And then there are several other areas where composites are used they are used in biomedical industry, they used in several places in places where you have artificial legs or in parts inside which are embedded inside your body for instance in devices which are embedded inside the body, they are also significantly used in several consumer goods products, they are used in agricultural industry agricultural equipment, they are used in computers, they are used in healthcare industry and then I am certain that all this still does not cover all the areas where composites are used.

But the point what I have been trying to make is that composites are used for in a large very large number of applications in all sorts of areas for different reasons; sometimes they are used to make things look prettier, in other cases they want if you want things to be lighter and yet strong they are used, in some cases they are used for making things highly temperature resistant or wear resistant or resistant to electromagnetic interference and so on and so forth.

So, for all sorts of reasons composites are used and what is important is that? When you are thinking of composites you should very clearly identify that, why do you want in your particular application that composite material should be used? Because that will help you engineer a composite based on your requirements and then you will have a more productive utilization of composite material. So, that concludes our discussion for today, tomorrow we will continue this discussion by starting to explain how composites classified? So that is what we plan to do tomorrow, we will discuss classification of composite materials.

Thank you very much bye.