Nanotechnology in Agriculture
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Lecture-11
Detailed Physical Techniques-I

Welcome back to the lecture series in the role of nanotechnology in agriculture for the application of nanomaterials in agriculture. So as hope now after the brief introduction about the current status of agro-chemical use in agriculture and how we can minimize their use, optimize their use in order to mean the requirement of food production, fodder production. We move on to the basics of nanotechnology where we have already talked about the classification of nanomaterial in terms of their shape and in terms of their chemical nature followed by that.

We have been talking about the different mode of synthesis where we have talked about physical synthesis, chemical synthesis and biological synthesis. So today will in this little bit more time on understanding some of these techniques and kind of overall outlines of these techniques.

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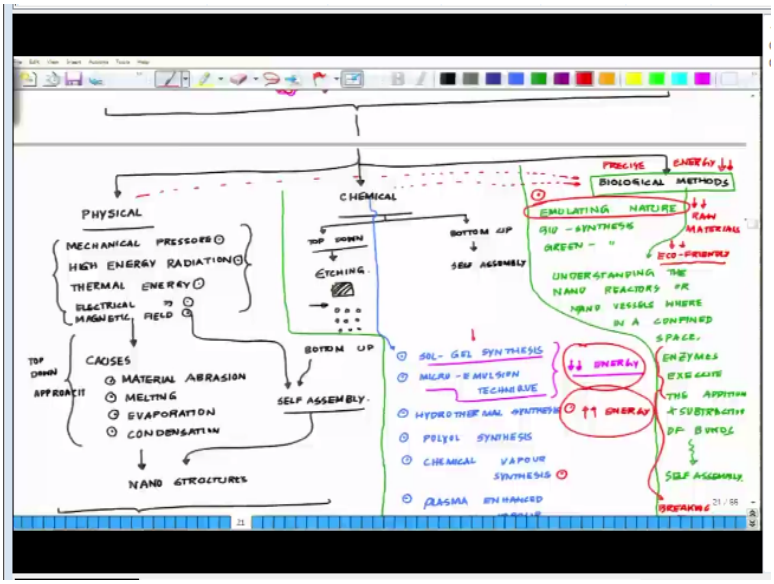

So, if you recollect in previous class this is where we started about the physical, chemical and the biological techniques and the physical I talk to you about application mechanical pressure, high energy radiation, thermal energy, electrical energy, magnetic field and which causing material abrasion, melting, evaporation, condensation leading to the formation of nanostructures.

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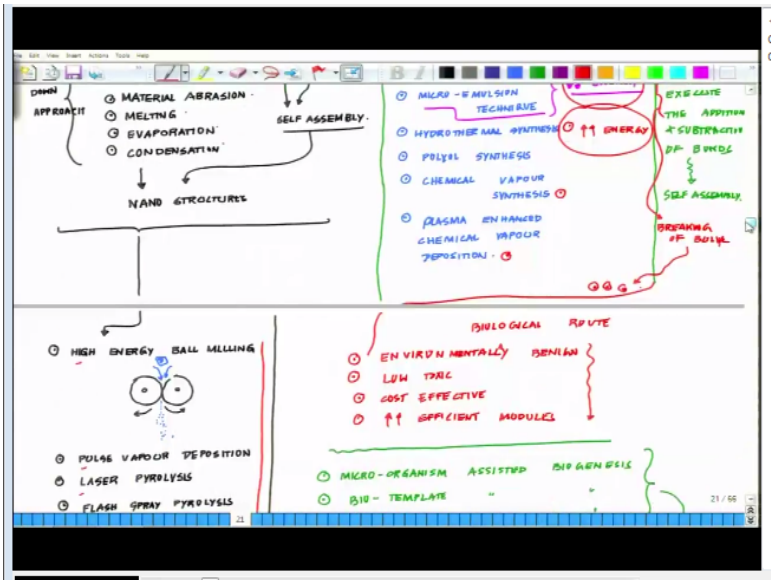

In the very first technique we talked about is high energy ball milling. So today we will talk a little bit high energy ball milling first what really is high energy ball milling.

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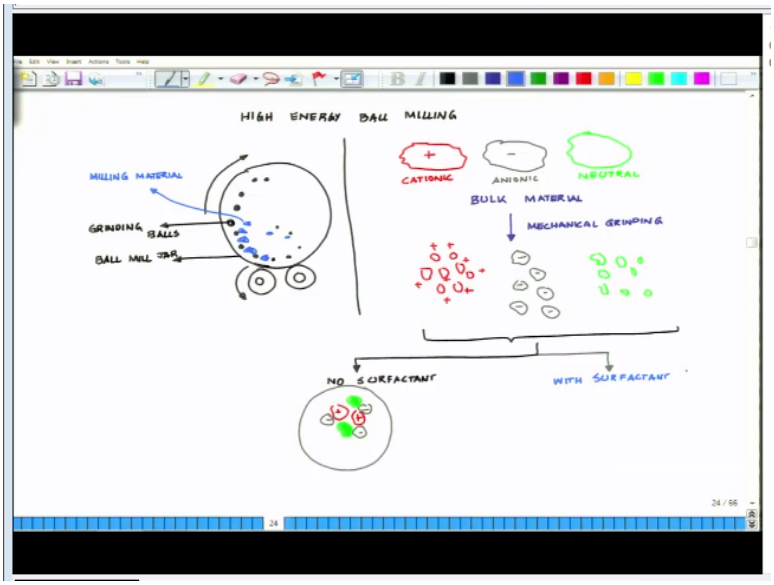

So, high energy ball milling, this is the very first technique okay, so high energy ball milling essentially what happen is that. Say for example you have this grinding ball which is moving in a particular direction and this supported by other small balls are there in this okay. So there is a grinding action which is happening which could you see out here okay and this is this whole thing is moving and inside it you are having the grinding balls.

So, the grinding balls are kept like this all over the place. So, this is the ball mill jar and these are your grinding balls and the materials what has to be grinded now is being put here. These are the material which has to be grinded okay is basically is a high energy ball milling system which has been represent out there. And now what will be showing is the schematic presentation of nanoparticles and this is using high energy ball milling method with and without surfactants.

So this is basic outline and these are the particles which are the milling material ok, now when you are using surfactants or without surfactants. So the properties could be either this could be cationic material or you could have anionic material, negatively charged or you could have something which is neutral neither positive nor negative. And these are your bulk material, it could be even your nitrogen, phosphorous, big chunk of nitrogen salt, phosphorous salts everything.

Now here you are doing a mechanical grinding, while you are performing a mechanical grinding what you are getting is smaller part of the cationic particles which are positive charged whereas negatively charged particles and neutral charge. But now the size has gone down, now what option is that it do not use any kind of surfactants. So what is the role of a surfactants, now this is one route where you are using no surfactant.

So what the surfactant does is these are small molecules which are inserted in between which tries to keep these individual particles separate from each other, of course one has to ensure that the surfactant is not affecting the property or the major property of the nanomaterial. And that is why it is always essential the surfactant should be used in very least amount and should not be a bulky molecule may be very small molecule.

But it will ensue that nanoparticle is separated out form the or nanoparticle does not its properties does not gets modulated by the surfactants property. So if you are not using any surfactants what you are essentially getting is a mixture of say something like this just in a smaller dimension and you have this negative anionic particles something like this. This is what is the outcome, now if you are using a surfactants this is with surfactant, with surfactant the story changes.

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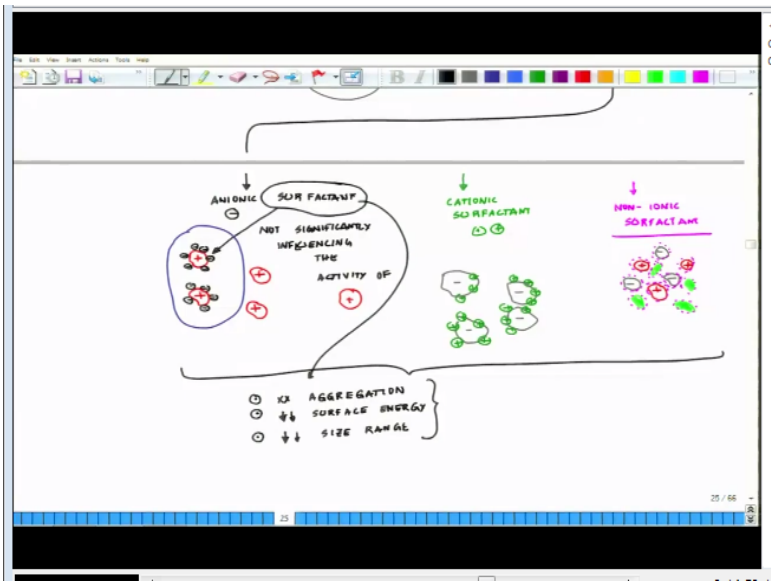

You could have anionic surfactants when you are using an anionic, so I will just switched to the next page that way will get more space to explain the drawing.

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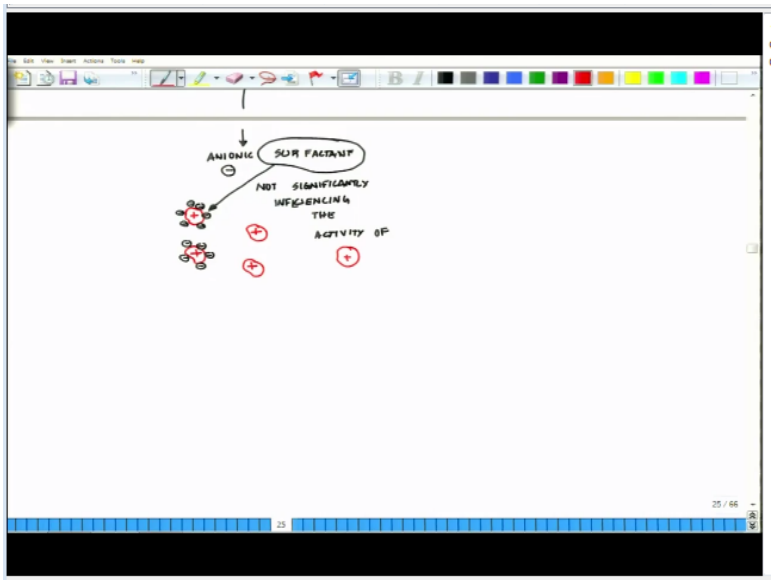

So, if you are using anionic surfactants something like this, so the anionic surfactant will attract the cation. So you have the cationic particles like this, this, this. So you have the anionic surfactants like this, but one has to as I am telling one has to ensure that this surfactants is not significantly influencing the activity of the nanomaterial or there may be a situation where surfactant may have to modulated its properties and that is what you are asking for.

So, you always have options what you are asking for, so it is in you control it is a control synthesis. So, this is the role of surfactants and we will talk later as we will go in the applications that how the properties can we modulated using surfactants and at times difference surfactants may lead to different kind of crystals like different resolution of crystal structures.

You get better crystals with certain surfactants with certain surfactants that crystal structure is not very clean. So and not only that it also influences the effective action of the nanomaterial it the presence of surfactants further helps in drug delivery that suppose I have to delivered drug in onto a positive surface. So, that situation these kind of delivery mode of surfactants make amount very handy because the negatively charged cover will attract your positive charge.

And it may get away to enter inside that particular delivery zone. So, the next say for example I do the reverse where we are having cationic surfactants, so when you talk about cationic surfactants. So these are all positively charge and here you are having negatively charge nanomaterial and on top of that you are having this positively charge cationic surfactants something like this okay.

Similarly you could have non-ionic surfactants the third one which is non-ionic. So, non-ionic surfactants are interesting, they personally do not have any kind of charge on them. So what you are having is a situation like this. You have positively charge particles, you have neutral particles like this sitting out there and now you are having this surfactants which I am representing as in pink something like this.

So in other word you are creating some form of distancing the particle by putting some kind of surfactants and surfactants are you use in your day to day life where you are using different kind of material to reduce the surface tension. If you see soap that is where you give the surfactants, soap we should soap the clothes properly. So when you mix soap in water you are essentially covering helping it to cover the cloth very clearly.

So, that it could you know it could remove all the odor from it okay. So, these are some of the very simple examples where post ball milling, you can modify the nanoparticle by going through

these kind of use of surfactants okay. So, this is what is called as your ball milling technique, high energy ball milling techniques where surfactant molecule absorbed on the surface of the generated molecule and help in lowering their surface energy by creating organic clear on them.

Thus preventing them from aggregation, so what are the roles of surfactants is this prevent aggregation, this is important than you are reducing the surface energy as I have already mention for that it leads to the production of nanomaterial with smaller size range and with desired surface properties size range okay. So as we will walk though the course you will see there are different places where surfactants have been used.

And this is the basic of using surfactants okay, now the next technique what will be talking about is inert gas condensation.

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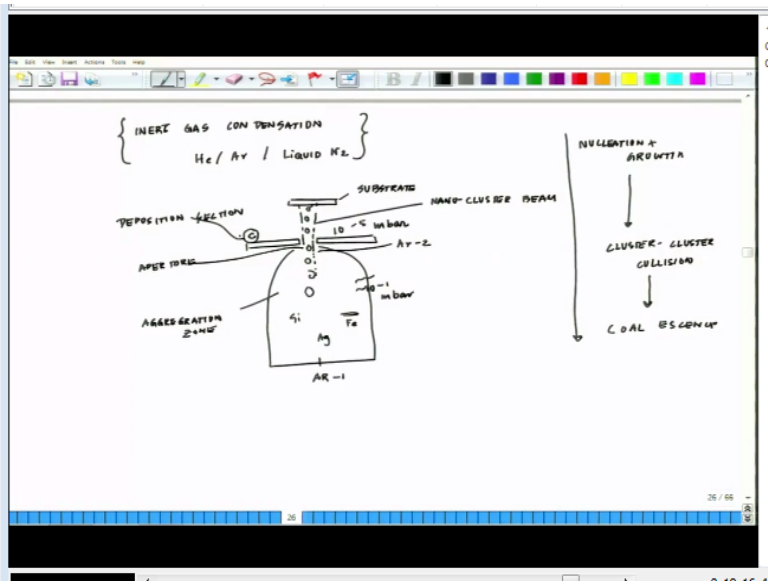

So, inert gas condensation is one of the most primitive method of nanoparticles synthesis that employs, this is called which employs inert gases, inert gas condensation. So inert gas condensation is one of the primitive methods for nanomaterials synthesis that employs inert gas like helium or argon or liquid nitrogen cools up substrate holder for the preparation nanomaterial evaporated material at transported with inert gas.

And condensed to onto a substrate attached to a liquid nitrogen and basically these kind of methods are used for synthesis of different kind of nanomaterials okay. So, essentially this is one of the very very old techniques where inert gas carriers are being used of synthesis of nanomaterial. It is something like this, say for example you have substrate out here okay and you have here is a chamber having argon which is being purge into this chamber.

And you have say iron, silver, silicon likewise and there is around approximately 10 to the power -1 bar pressure out there and this is called the aggregation zone okay. And then you have this aperture here out here now C is your deposition section that is out here. So what is happening is that substrate is sitting here and so that carrier is carrying these particles and depositing it on the substrate as I was mentioning.

So this is the substrate and this is the nano-clusture beam and out here the pressure changes if you follow it pressure is continuously changing. And these kind of techniques are being used there are 3 different states, one is nucleation and growth that is the first step followed by cluster-cluster collision. And lastly you are having collision, these are the 3 steps where inert gases condensation is being used.

So synthesis different kind of nano-particle, so if you look at these kind of techniques by this time you must be realizing as I was mentioning in the previous lecture that much of this techniques are requiring pretty sophisticated tools and high temperature, high pressure. In other word these are all high energy intensive procedures which are followed. But in the beginning these were or these are the major techniques.

Now slowly we are drifting away these are used of course for large scale synthesis or for specific purpose. But much of the biological applications are currently relying on much simple low energy intensive techniques and which will coming and there are reasons for it of not using these kind of technique for synthesizing nano-materials okay.