Nanotechnology in Agriculture
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Lecture-37
Futuristic Multifunctional, Sustainable and Green Nanomaterial

Welcome back to the lecture series in role of nanotechnology in animal production. So in the previous class I highlighted upon 3 aspects and let us revisit those one is a need for clean water.

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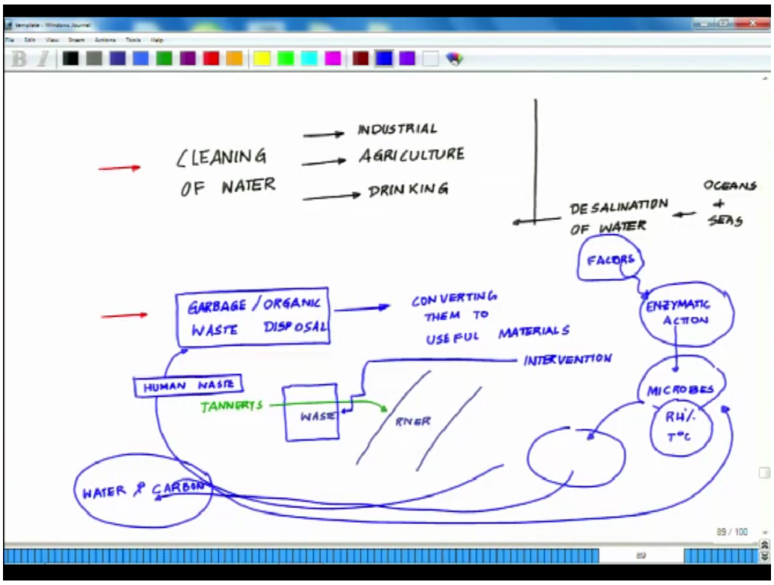

One of the major requirements of all the modern societies whether urban or rural or where ever ok, for industrial application, agriculture and drinking and there is tremendous trust on desalination of water so that we can use the ocean and the sea and those resources, second area where there is tremendous thrust is the garbage or organic waste disposal converting them into useful materials.

Similarly I give you an example from the DRDO the government of India where human feces are being converted into water and some form of carbons which of the mine by the use of microbes and that is what you must have seen in terms of green toilets in trains as well as in Army post in remote places ok. Then next I introduce the concept of multifunctional sustainable green materials, a multifunctionality in terms of same material, same material x having multiple functions, so agriculture, energy, waste management, water purification, electronics likewise.

Yet the material should be environmentally benign easily degradable, an elemental composition or component should be easy save, acceptable, compatible with the living system. To give you an example say for example last I would say 78 years of electronics is mostly on case study of silicon ok.

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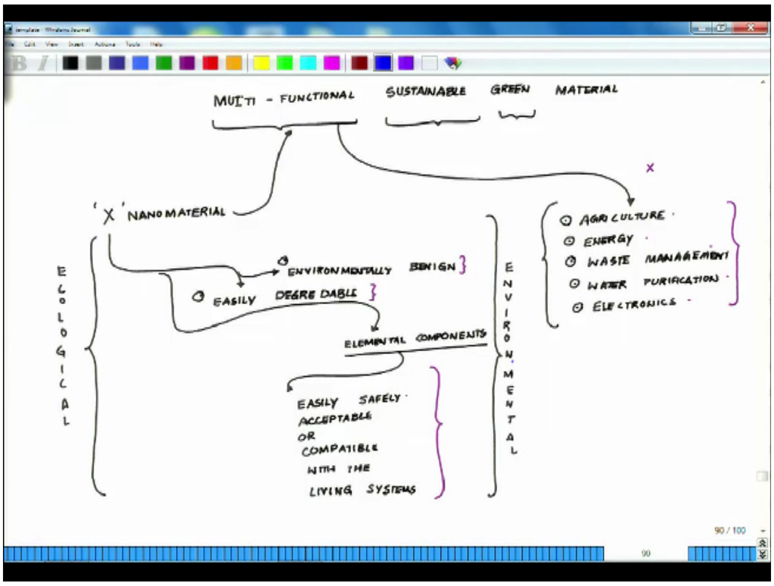

So specially the crystalline silicon.

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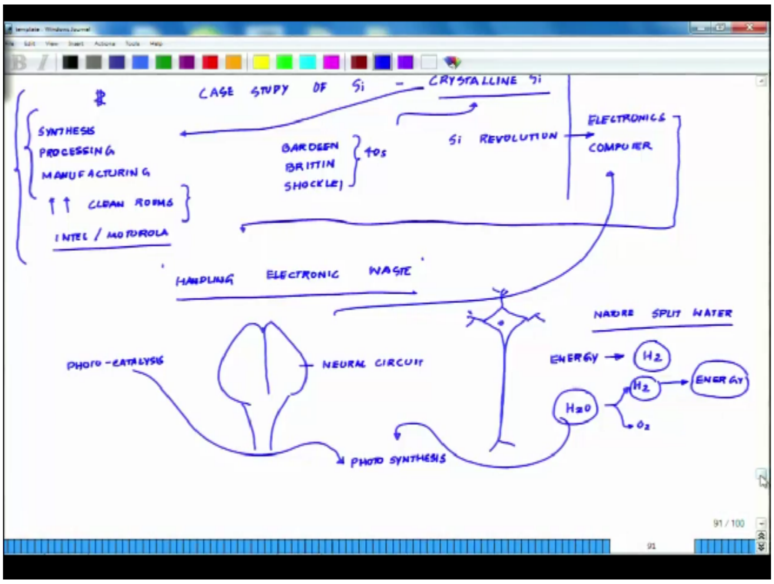

So the crystalline silicon if you go back so the journey of the silicon revolution are specially the crystalline silicon revolution which are the revolutionaries our electronic world started with Bardeen, Brittin and Shocklei, ok Bardeen, John Bardeen, Brittin and Shocklei and this was around the era of 40s, so 1940s and 50s. This completely revolutionaries the word of computational electronics and hardwares and all the computers, all the gadgets what you are using are all made up of crystalline silicon.

Now crystalline silicon comes at a cost what are the cost in terms of rupee if you look at it and we are talking about synthesis it is a very, very processing and manufacturing of chips. These are exceptionally cost intensive process you need pretty high quality of clean rooms, almost zero dusty clean rooms, zero particulate free clean rooms and there are very few facilities like if you look at the currently chips of Intel.

Motorola and may be few others, that is it, only handful of companies are involved in manufacturing the chips for all the electronic application. But then the next problem is how to the; handle handling electronic waste think of it, you in your lifetime use at least with the current estimate I see if we do not use a cell phone more than 2 years or 3 years ok.

That is the kind of stretching it, so each of us are consuming some basketful of cell phones, they have to be dumped, they have to be destroy, they have to refurbish, how we do so the electronic waste, I will look around computer huge screen, huge monitors, this has to be dumped where are we dumping them, manufacturing world, the world of industry, the world of modern day living.

All the huge gadgets what we are using where are we going to dump them and if you think even if you give 1 minute of your whole day you will realize that this is one serious problem which is going to haunt us in decades, centuries to come, how to really destroy them, how to ensure that all those extraordinary kind of material what we use like crystalline Silicon and several others.

They will get degraded and come out the nature, well we all enjoyed use all of them but that is where the future lies, what kind of machines are we talking about, what kind of because even if we look at the size of the transistors they cannot go down beyond a point, if you follow those of you are interested in following how the size is getting decrease and aspect ratio is getting decreased.

And follow the More’s law there is a limit, there is a physical limit of which you go beyond that you will have quantum tunnelling and all other tricky things which will come into play, there of course emerging feeds like spintronics and others where the plot talking about using the spin signature for computation. Yet there is another area which also popping up is called DNA base computation.

Though it is in very infancy thinking of computation, so led to a comparison for a minute since some of you have some knowledge of biology, now if this is where all our electronics and computer world is. So where is our inspiration to look at it to counter this? So to counter this our inspiration is here neural circuit, a brain circuit. Brain circuit does the same thing as what a computer does ok.

But it does in a very different way and it uses simple neurons to do the computation unlike those chips which needed these kind of extraordinary tough settings to be manufactured, it biologist as it in a very simple way or this is one example for us to look, the next example for us to look is how nature split water, this aspect is again very important for us to appreciate that for energy there is tremendous trust on hydrogen one of the cleanest form of energy.

And then what could be the major source of hydrogen it will be water, if you could split water into hydrogen and oxygen you can use this hydrogen for energy and how nature does it, nature split this water in photosynthetic assembly, in other word this process nature does actually a photo catalysis, but nature photo catalysis is being orchestrated in photosynthesis. If we locate photosynthesis this water splitting is being orchestrated by something called manganese cluster.

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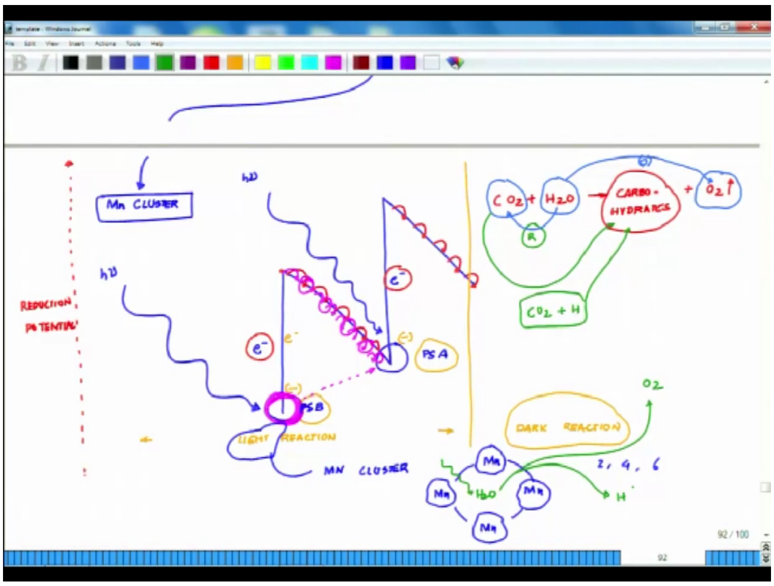

So those of you are aware of it there is something called Z scheme of electron transport ok, so there are these 2 photo systems sitting at different redox potential photo system say you can call it A, I call photo system B, now both photo system upon receiving light energy h mu excite and both this electrons so on the left hand side if I put reduction potential or redox potential scale ok.

Now both this electrons which are emerged out are having a different reduction potential, so these electron after climbing house back and does a lot of reduction process, will come to that in the second ok and if you look at the reaction of photosynthesis is this reaction, oxygen as a by-product coming out and carbohydrate ok, so what essentially happens is this, in this process 100 years of study people realise that it is a water which is splitting up into oxygen one product and this hydrogen comes here.

So this when it is getting a split up there is an oxidation which is happening you are losing nitrogen and this hydrogen comes and reduce this carbon dioxide to generate carbohydrates the food ok. So this process out here is a reduction processes which is happening. So Co2+ (()) (13:47) so I am not doing it by stoichiometry but this is what is precisely happening. But then what is out here, so this part if you look at photosynthesis so this aspect of photosynthesis is the light reaction.

And other half a photosynthesis is the dark action or where you have the Kelvin cycle and all the things which are taking place. Now for system one excites 1 electron and this electron travelling reducing an eventually whereas photosystem, the other photosystem are excites in electron. So once both of them generates an electron they are devoid up, they are minus electron ok. Now they will almost behave like free radical.

Now they have to be brought back toward to their ground state, they have been brought back by the down state win for system B supplies it electronic hub through and bring for system A with ground state fine, no issues, but what will happen, what will be the fate of this photosystem which has donated its electron through a very cascade way to for system 1, is the electron has been donated here.

Now by the way just for your understanding this electron which goes it reduces there are intermediate feature here I am not getting intermit yet. So essentially when I say this electron reduces this, does not mean that is single electron which is moving it is basically there are complexes which are getting reduced reduced based on their reduction potential ok.

Now who is going to bring this oxidised photosystem are in this case what we have label it as photosystem B back in its original shape ok. So now that is being brought by so it needs an electron this electron it gets just underneath it, there is a small cluster sitting and this cluster is called what as telling here is manganese cluster. Manganese cluster is a very interesting structure.

There are as of now understood 4 different manganese sitting at different oxidation state. So manganese could have multiple oxidation state as we know it could have 2, 4, 6, likewise ok. So this manganese this this different manganese which are sitting there are sitting at different oxidation state and their oxidation state cannot be changed ok. They only good fluctuate as a 2 way switch you know they can move say +1, -1, depending on water stayed there.

And it is very poorly understood that water molecule gets trapped into this thing and what it does is it splits that water molecule by oxidation reduction really to oxygen and generate reducing force in the form of protons or in forms of hydrogen ok. So I will close here and continue from here our journey of how these are going to inspire the next generation of nanomaterials, thank you