

**Advance Manufacturing Techniques**  
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**Vaccume Forming**  
**Lab Session – 6**

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Hello and welcome to this new experiment on Vaccume Forming, it is the process which is highly used and recognized by the industries to do the packaging, particularly of parts – plastic parts etcetera. However our interest is sort of micromachining and micro fabrication, so therefore in this particular aspect also we can actually vaccume form plastic sheets into devices which can be used for micro **footing** applications. So I am going to now illustrate the basic process that how the vaccume forming can be done, and then later on demonstrate one example of forming which would typically mean to take a plastic sheet of ABS and then trying to heat it to its forming temperature.

So the basic idea here is that supposing there is a very complex mould which you want to cover with plastic in the interest of packaging this. And you can see here, this is the four i laboratory written on a rapid prototype part, which has been done using you know another plastic ABS plastic through the RP machine. And so basically we want to create a situation where we want to package this using another plastic. So this right here is the controller for this machine, and the

way to switch it on is basically here the main power inlet into the system, by turning on this MCP. Following by you can see there is an auto and manual option, by the controller can be taken into both modes, we are going to do manually here. So we just put it towards manual side. And then go to the next step heater, and try to switch on the heater which brings in the signals in all the different heating zones.

Ok So the heater is actually controlling the unit right here, which is actually a infra-red heater with set of elements which are all around and these are going to provide uniform heating to this sheet later on. As the heat was going to come exactly over this sheet and it's going to heat this sheet all the way to its forming temperature, so that it becomes you know it becomes in a plastic flow state and can actually with work vaccume pulled into a complex architecture which has been placed in between and in this particular sheet. So after doing this heater on, we can actually switch on the vaccume pump. A certain vaccume pressure to be put in particularly in this unit, which would be able to take this sheet which is in the plastic state now I try to format over the surface that we are concerned there.

So this right here is the ABS plastic sheet which is going to be heated to the forming temperature, so that it can form around the particular part create the packaging. What we have to do here is to put this sheet right in this particular position. And you can see here, right here that there is a rubber packing, which is there actually create a good seal between the sheet and this this plastic sheet and the metal body. And what we are also going to show therefore you know the idea is that this goes over that particular region which would actually vaccume pull, and we need the vaccume do not leak. So therefore, this a right here is the rubber seal for that there is also a clamp here, which goes down all the way to this to grab this sheet over this particular you know rubber packing or casing which is there and then you can actually fit to this sheet tightly over the top of the system.

Now you can ensure that as the sheet would this table would come up with the work piece, and come all the way here, there would be a proper sealing of the vaccume between the table and the top portion of the plastic sheet. So once this is done, now we are we have mounted the cover, which is going to be form, we have also mounted the sample in the state. So, there are two sample here as I showed you this is the sample is going to be embedded within this or the package within this particular material. So I am going to put this sample in in this manner right

here. And there is another sample which I would like to just demonstrate because the question of micromachining comes, so basically this is a ((Refer Time: 04:31)) aircraft fuselage, this is also been developed with rubber prototyping system. And we are going to package both of them together at single go.

So I am going to put this four I laboratory inside, then I am going to just put aircraft fuselage, you can see this is the fuselage ok. Again, parallel to this, so that you can see the resolution at which this forming process can happen or take place. So, I am going to just align this properly and put the aircraft fuselages just along with this tab written with four I lab ok. So once this is done now, we are set with the work sample on the work state. We are also set with the the forming sheet, there will be a sheet and we are duly clamped, we have chord that the vaccume doesn't escape, and now we start the system, on for the forming process to happen.

Coming back to this controller now, we have to now turn on the heater ok. So there is a switch you can see here for the heater. So as soon as the heater is on, you can see that the state actually brings the heat are all the way to this particular sheet, and then we want to see and you can actually see inside, if you go inside very difficult for the camera, but the ringlets are disappearing in the sheet. And if it is fully ringlet free in that even what we want to do, is to sort of heat to this particular table and take this particular heater back at the same time. So we just heat the table on, and takes the heat that all the way back, and you can see here the moment it has come, you just turn on the vaccume, so that the ABS plastic sheet now has formulated completely over these two features, so that you having proper packaging of the system as such. And there is no vaccume leakage between the same.

You can this particular part as well as this particular part had been fully packaged with the system. The idea ((Refer Time: 06:31)) this particular forming process, that is the feature side is the very small, let's say for example in the case of micro channel, we want to build the channel out of some of kind of you know plastic sheet, let scarily heat with laser machining etcetera. We can easily use the secondary plastic the ABS plastic to be vaccume form over those moulds, so that we can eventually formulate this channel.

So what we are going to do is, there is a switch on this controller right here for the fan. So this switches on the fan so that you know there is a heat transfer because of forced convection, and

there is a removal of the heat so that the surface temperature of this particular ABS plastic comes down. And once this is done, what we can do is basically use this particular emergency switch to actually create small pressure blows so that we can remove this particular acrylic sheet out of this structure after which we do the vacuum off ok. And then we try to take this table down once more, so the table goes all the way down here. And you can see now that this is the well formed structure, formulating out of this particular objects and the sheet, beautifully formulated that packaging these objects within the state.

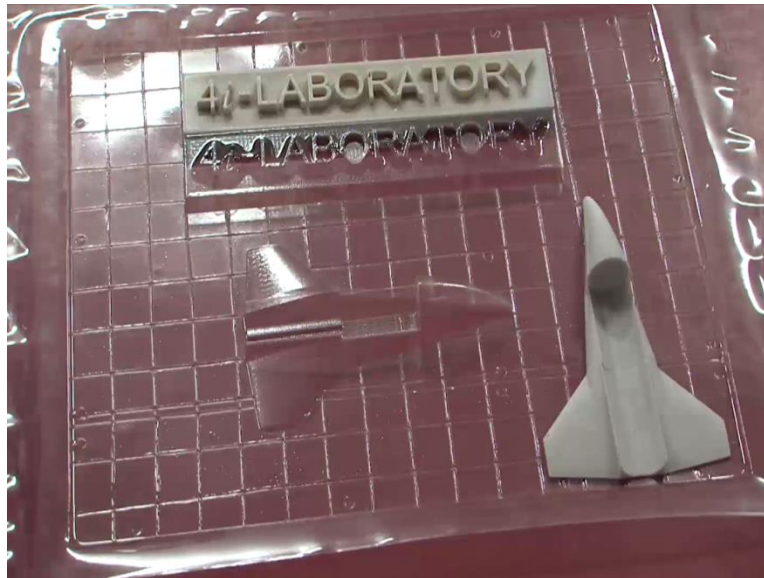
I can actually remove these structures from this particular sheet, and I can have, I will show you the formulation later on once this is being done, so all this has come down and if we remove this particular sheet here ok. I can see that this is the well formed sheet over the structure that has been formulated, so this is how you do whole vacuum forming process.

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So you can see that two forms right here, this is the packaging of the four I laboratory, and this again is the packaging of that particular fuselage of the aircraft. We have just kept it for representational purposes, of the idea here is that very small features can also be very well formed with this particular method.

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And in future we have a scope of doing micro fluidic using this particular sheet itself, which is formulated in terms of or in shapes and sizes of micro channels ok. And then we can inject through the sheets and puncture the heats very easily through syringe needles. And so we are soon going to bring out a module, where we can show how this micro fluidic channels are drawn by such vaccume forming processes.

So as you can this particular feature right here this is that fuselage feature is comprised of various different shapes and sizes, contours, edges which are even them. And so the idea is that the process is capable of doing forming across such edges, and this is itself very big you know, it gives lot of it says lot of things about the process capability of such systems. So you know vaccume forming here although is used measure in the majority of the cases for packaging, can also be used for a carrying micro devices and micro features ok. And this is very useful tool, which is going to provide some of the very amenable disposable kind of plastic systems which can handle micro flows within small domains.

Also one more important thing that I would like to mention here is that once the sheet is heated to a certain structure and supposing you want to by any chance you have committed an error, and you want to just reuse this particular sheets, there is an option, which is available. If you just, don't remove the sheet at that particular instance from the machine itself. And you just heat the

formulated sheet or the formed sheet again with the set of heaters, there are few cycles up to which the sheet can sustain itself, only thing you have to see inside is that the ringlets are totally eliminated because the mesh before the next round of forming operation start should takes place. So in a way, it is a reusable plastics making amenable the ABS plastic sheet which formulates the cover material in this case to be reused many times, until it achieves its you know because of repeated plastic flow may be sectional thickness comes to level where there can be failure ok. So before the sheet has heat that particular thickness which is also called the failure thickness, you can reuse the sheets again and again for doing this forming process.

So the whole vaccume forming unit consists of three different components; one is three different module; one is this main forming unit, which is comprised of a series of infra-red heaters which is just underneath this box here. The box is capable of movement, so it comes and slides along the guide rail all the way to top of this particular area. It also comprises of a clamp, where you can open and hold this clamp, which can actually be used to clamp the plastic sheet to the machine. There is in fact a spacer, which actually determines that there is complete vaccume retention, when the vaccume pressure is introduced. There is the worktable on this particular sheet, which is having small holes through which the vaccume concerns pass. And the idea is to pull the sheet after heating it to the forming temperature, so that it sets on the top of the is a small objects, this is one unit.

The other unit here is, the controller set, which is used to drive this unit here for its different operations like heater temperature control, heater timer on, process can be automatic or manual, so there is an option where you can actually program the process for a few minutes of heating. Typically, the heating time, which is needed for ABS plastics that I will be demonstrating later on is close to about one – one and half minutes. And the way you see it is also to when the plastic is being heated, you will see the ringlets appear and then they disappear, meaning thereby the plastic has come into its totally you know flow state and this is also known as the forming temperature of the material.

There is the fan unit here, which is used in case the plastic has been fully formulated over the surface to cool down rapidly; so you can have forced convection, which will cool down the plastic, which has been formed. And there is a compressor set right here, which is also a part of this module, because you need to generate a sort of vaccume level for feeding this machine so

that you can have vacume assisted forming. So in fact this whole unit comes in these three parts

- the main unit, the controller and the compressor.