Dialogue, story and plot : NAPA (Nanopatterning) European project which explains the fabrication processes at nanometric scale.

Title of the movie : « A precious envelope for budding scientists. »

Two children : Nat and Pat are sitting on a bench in the park and talking .

A man is sitting on the bench opposite them. When he leaves, he forgets an envelope that says : « NANOLAB »
The children decide to take the envelope back to the man. He works in a lab. When he opens his envelope, he checks that the bioplume in it is not damaged. He takes the children to the clean room where the smallest bit of dust is not allowed. They must wear white protective clothing.
There the scientist shows them the intact bioplume with a very powerful microscope.

SCIENTIST : A bioplume is like an ink pen with a reservoir where the ink arrives and a feather of nanometric size invisible to the naked eye. … like an ink pen with a reservoir and a tiny little feather

The characters in this story :
Nat : the girl
Pat : the boy, her younger brother
The scientist : Doctor John Old
Kira : the lady scientist
Nano : the yellow nanoperson

NAT : What good is it to write with a pen if you can't even see what you're writing ?
NANO : What do we do with a bioplume ? We can place DNA molecules that contain a specific gene of a disease inside minuscule drops. And when we analyze a patient's sample, if it contains this gene, the nanodrop will become coloured under the light of a laser beam.

SCIENTIST : the bioplume therefore allows us to make devices that look like electronic chips which allow the doctor to better diagnoze illnesses.
NAT : Will it help cure my sick grandma ?
SCIENTIST : maybe not cure her but at least to take care of her better. We can also predict illnesses before they start.
PAT : Thanks to this microscope you can do all of that.
SCIENTIST : not only that but the exploration of the nanometric world has started because of these observation technics. Would you like to observe an ant ?
NAT : Oh yes.
SCIENTIST : Here the ant is in a vacuum. I switch on the electron beam that will allow us to see it.
Here, you can operate it. Who would like to take the controls ?
THE 2 CHILDREN : me !
SCIENTIST : you turn this button to zoom in and this one to focus. (picture of the ant)
PAT : Wow, the head is incredible.
NAT : Look there's a hook at the end of its leg.
SCIENTIST : Now you see why, when you observe these small details, you can better understand the ant and how this small world works.
NAT : How little exactly is this world ?
SCIENTIST : I'm going to show you something. You will understand everything better after that.

The scientist shows the poster :

MACRO MICRO NANO

SCIENTIST : Here we are at the same scale as a person and then we meet the ant that measures just a few millimeters. This is what we call the macroscopic world. Then, measuring just a few microns, there is for example a human hair. From now on, anything smaller is invisible to the naked eye, like bacteria or cells. We enter the microscopic world.

Below that comes the nanoscopic world : we find viruses that measure a few hundreds nanometers. And even smaller are molecules and atoms, basic components of all matter, living or not.

NANO : Exploring the nanometric world is to get inside matter. Let's take a trip to the heart of Nat's tennis racket. It is composed of fine carbon nanotubes extremely resistant and unbreakable. We can continue. Here, we are in front of a carbon atom. There is the same size relationship between this atom, a tennis ball and the Earth.

SCIENTIST : Since we now can work at the nanometric level, it has been possible to create new materials and new devices.

NAT and PAT : How do you create nano-objects?

SCIENTIST : That is our specialty in this lab. We call it nanofabrication. Would you like to find out about these processes?

PAT and NAT : Oh yes! *The 3(the scientist and the children) join Kira in her lab.*

KIRA : […]

NAT : We'd like to know how you can make things so tiny.

KIRA : Well we are inspired by the writing processes used from the beginning of times and we have been experiencing with many processes like soft lithography and nano-imprinting too. Look at this small flexible screen. Surprising, isn't it ?

NANO : Soft lithography is not very complicated. Watch! I use an elastic polymer stamp that I moulded earlier. I put the ink on it. It's the inking step. I let it dry. I turn it over and I put it in contact with a surface. Next, I remove the stamp from the surface and the ink that was on the stamp's features is left. This is how we make drawings with molecules.

And as for the nano imprinting, here is a mould made out of a hard material that can't be bent or broken and a sample covered with a thin layer of « resist » that softens while heating ; we put these 2 elements in contact and we apply pressure. The layer of soft resist flows and positions itself around the mould patterns and takes the same shape. We remove the mould and we get the structure.

SCIENTIST : Look at a stamp and now look at a print. These printing techniques are based on the same principles as the ones that were used by Gutenberg when he invented the printing process. Except now we can write a full Harry Potter adventure on the stamp of a letter.
NAT : So Cool ! And can we do other things with it?
KIRA : Yes, this foldable screen prototype, for example.
PAT : that means that we'll soon have screens like this in our school bags ?
KIRA : Ah!
SCIENTIST : And I'm sure you have heard about the environmental problems. You know that we are researching new kinds of clean energy that are less polluting for our planet ?
KIRA : And so this is also the subject of our research. Look. You see this device ? thanks to the process of nano-imprinting, we're trying to find a way to improve the quality of photovoltaïc cells.That's the name of the cells capable of transforming the sunlight into electricity. Here is another example that you might relate to. Do you know how to use a stencil set?
NAT : Of course, we know it.
KIRA : Well, we use the same principle to integrate circuits that are used in mobile phones using a technique that carries the name : stencil. Look, thanks to this innovative technology, our mobile phones will become real pocket computers that can do everything, well, almost everything.
NAT : Do you always use such simple tricks to draw nanocircuits ?
KIRA : It might be simple in principle but the experimental conditions to make everyting work are very complex. And it requires a lot of work and deep understanding to find the right parameters and settings.
SCIENTIST : for each process, we use different moulds which we fabricate as well… But Oh my gosh, we will not have time to talk about it, I have to go and pick my kids up and I'm already late. However, if you're interested, we take on people your age for internships. You are most welcome. So, we'll see each other soon.

[…] Six months later.

SCIENTIST, *speaking to the children* : See here, you are not in focus. You have to try to move this button here so it will be a little bit clearer. Yes, that's a lot better, you're heading in the right direction. The mould of your nanoperson will be a success.
NAT : Oh I would like to do this job later. Pat and I would like to ask : what kind of studies do we have to do?
SCIENTIST : Well, first, you need to get yourselves in a scientific curriculum. Next, you will have the choice between many classes and different jobs from technician to researcher or engineer.
NANO : In fact, research on the nanometric world is at its beginning. There are numerous aspects left to discover. It is maybe up to you, tomorrow's researchers, to explore this world.

This film has been achieved under supervision of the CNRS.
LAAS, laboratoire d'architecture et d'analyse des systèmes. 25 February 2008

VIDEO EXTRACT : The bioplume.

SCIENTIST : Everything is fine. It's still intact.

NAT : How do you see it ?

SCIENTIST : It's this part here that is very fragile. There's a canal where the ink arrives and a feather of nanometric size. We can't see them with the naked eye which is why we verify their state with this very powerful microscope .

PAT : So, that's what a bioplume is ?

SCIENTIST : Yes. It's a bit like an ink pen with a reservoir and a tiny little feather invisible to the naked eye.

NAT : But what good is it to write with a pen if you can't even see what you're writing ?

SCIENTIST : Ah ! Good question. Let's see.

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VIDEO Script : The insect.

Scientist : Would you like to observe an ant ?
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VIDEO EXTRACT : From Macro to Nano

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VIDEO Script : the mobile phone.

KIRA : Do you know how to use a stencil set?
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