"Laser nano-chisel" – novel lithography method for surface structuring in micro and nanoscale

Most likely everyone knows "The Princess and the Pea" fairy tale written by Hans Christian Andersen. In this story a princess has a bad night's sleep due to a pea under her mattress.

In this project instead of pea grains we will use tiny metallic particles - nanoparticles. They will be made from gold, silver or aluminum. The role of the princess will be given to light, and more precisely to ultrashort pulses generated by a femtosecond laser. Even though the nanoparticle is more than thousand times smaller than the diameter of a human hair, it can "trouble" light pulses, a bit like the pea "troubled" the princess. In more scientific language, the particle will absorb a significant portion of the energy of the light emitted from the laser.

In the project we will study how light interacts with layered metal-dielectric structures. We will make several stacks of multiple layers. However, instead of mattresses, we will use thin transparent layers made of glass-like materials. Between these layers, instead of pea grains, we will put nanoparticles of various metals (we will use some vacuum deposition systems for this step). Next, we will illuminate these samples with a laser. As a result, part of the glass-like layer will be removed. In this way, we will be able to shape the manufactured stack of layers in a manner similar to the way an artist carves a piece of wood with a chisel.

We want to learn the secrets of "laser nano-chisel" – the new method of laser structuring and understand how the constituent materials, type of laser used, and other parameters affect the final result. So, at the final stage of the project, we can create surfaces with various patterns, which will make the thin, almost flat structure behave like for example a magnifying glass - focus light. Soon, such structured elements can replace lenses in our phones and cameras.

And it all started with a pea ...