Virus filters for medical diagnosis

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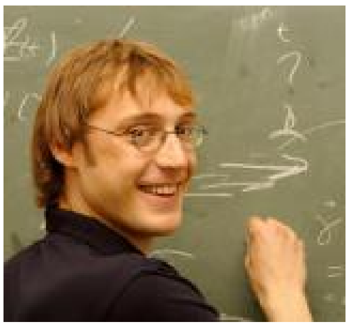

Richard Stein

In biomedicine and biotechnology the smallest, complex, compound sample quantities must be reliably processed. Microsystems with new mechanisms of action for pumping, filtering and separating will manage this task with great efficiency in the future.

Providing reliable evidence of viruses in human blood presently requires time- and labor-intensive molecular-biological procedures. Established methods are particularly hard pushed to produce evidence when the viral burden is very low, for example during a phase of therapy. This could soon change.

While developing new types of micro-pumps without movable parts, scientists from the Fraunhofer Institute for Biomedical Engineering IBMT came across an unexpected phenomenon: stable turbulence structures formed in the microscale pump channels.

The nano- and microparticles actually intended to verify the pump effect accumulated in large quantities in the channels. The vortex patterns completely filled the whole microchannel, creating a virtually 100% trap for the particles that followed the generated flow profile, although there is a very large cross-section to flow through.

"The development of flow vortices is nothing unusual on the macroscopic scale. However, in microchannels the flow lines almost run in parallel," explains Richard Stein from the IBMT. "The question, therefore, was, how is it possible for vortices to be formed from this which were sufficiently stable and effective for the concentration of nanoparticles?"

Experiments were not successful in determining the parameters by which the filter effect could be systematically controlled. This is because in the pump mechanism examined, high-frequency electrical traveling waves propel the fluid into the microchannels, superimposing a large number of effects on one another.

"In order to understand the complex procedures, there was a clear need for a theoretical description. My task was to describe the surprising phenomenon and to make it controllable," reflects Richard Stein. In his thesis "Mathematical modeling, analysis and numerical simulation of electrothermally driven micropumps", Richard Stein succeeded in explaining the development of the vortex pattern. To this end, he had to factor in all the relevant processes - of an electrical, thermal and hydrodynamic nature - in a three-dimensional model. Mr. Stein will receive the 1st Hugo Geiger Prize for this paper. The findings contained in the paper explain the observed effects completely, so that now both effective micropumps and efficient particle filters can be developed and built for many biomedical applications.

Source: Fraunhofer-Gesellschaft (news : web)