Novel bio-compatible tracers for Positron Emission Particle Tracking

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To study the flow of objects (tracers) in opaque flow processes, the PEPT (positron emission particle tracking) technique is utilized. The PEPT technique is based on the same principle of PET (positron emission tomography) which detects the characteristic back-to-back gamma pairs caused by positron-electron annihilation. The annihilation takes place within a few millimeters around the tracers labeled with positron-emitting isotopes. PEPT allows locating the droplets or ice particles (depending on the surrounding temperature) in high spatial and temporal resolutions. This makes the technique promising in a number of medical applications that require observation of fast transient phenomena e.g. heart hemodynamics, lungs aerodynamics etc. However, the tracers utilized so far are based on activated solid particles of a micrometric size which are hardly removed *in-vivo* after the test. In this contribution, we propose new tracers based on frozen radioactive solutions rather than activated solids.

To follow the flow of droplets and ice particles by PEPT, positron-emitting radioactive solutions were produced in the Tromsø PET Imaging Center. Gallium chloride ($^{68}GaCl_3$) eluted with 0.1 M HCl was produced by the GalliAd gallium-68 generator (IRE-ELiT S.A.). Droplets of the solution were dispensed by the micropipette (Eppendorf) in linseed oil. The linseed oil is stored in a -18 C freezer before ice droplet experiments. Once dispensed into the linseed oil in a 15 ml centrifuge tube (SuperClear, VWR), the tube was moved into the detection field of view (FOV).

The preclinical PET (positron emission tomography) camera, LabPET8 (TriFoil Imaging Inc.), was used as the gamma detector matrix. The LabPET8 consists of 3072 phoswich detectors surrounding a cylindrical space of diameter 162 mm and axial length 75 mm. More details about the detectors, construction, and electronics can be found in LabPET related literature (e.g. [1]). A timestamp was inserted into the data stream every 5.24288 ms. The algorithm for tracking droplets and ice particles used in this study is based on the same principle developed and used in Ref [2].

A typical track of a freezing liquid droplet is presented in Fig.1. As it follows from the figure, the steady motion of the droplet takes place from the very beginning of the deposition process due to the high viscosity of the carrier oil. The droplet moves at its terminal velocity towards the bottom of the column and settles within 20 s.

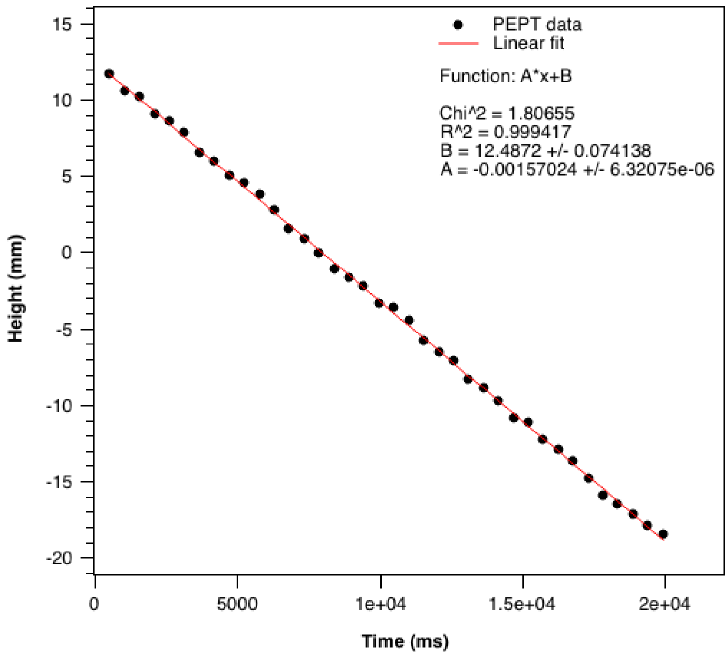

Figure 1

According to a supplementary simulation in STAR-CCM+ using the built-in melting and solidification routine, the settling time is long enough to form a solid ice shell around the droplet. The solidified droplet is of a spherical shape; the droplet turns to an ice tracer no longer than in 2 minutes after the deposition. The tracer can be further used *in-vivo* melting after the test.

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References

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