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CONTRAST-ENHANCED MICROCT AND DEDICATED IMAGE PROCESSING FOR THE MORPHOLOGICAL CHARACTERIZATION OF MICRO-CARRIERS FOR LARGE SCALE STEM CELL EXPANSION

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Summary: Tissue Engineering (TE) is an interdisciplinary field aiming to provide solutions for the regeneration of organs and tissues. Many typical TE processes make use of stem cells due to their pluripotent behavior and their self-renewal capacities. For large scale stem cell expansion, micro-carriers are commonly used. These are typically degradable porous or non-porous beads on which cells are seeded and expanded during culture in a spinner flask. Only limited information is provided by the manufacturers on the morphological characteristics of the micro-carriers even though this information is crucial to improve process parameters for cell expansion, such as the cell seeding density, culture time, etc [Sart et al, Methods Mol Biol 2016;1502:87-102]. X-ray microfocus computed tomography (microCT) could provide a solution, as it allows for non-invasive analysis of the 3D morphology of porous materials. However, many commercially available micro-carriers are polymeric and, as they should be characterized in wet state to obtain the proper morphometric characteristics, there is no or negligible image contrast difference between the micro-carriers and the surrounding liquid. Therefore, we investigated the potential of contrast-enhanced X-ray computed tomography (CE-CT), combined with dedicated image processing and analysis, for the 3D morphological characterization of polymeric micro-carriers.

In this study we used a polyoxometalate (POM) as CE-CT contrast agent for non-invasive staining of the micro-carriers. For each individual micro-carrier, a binary volume was determined (Otsu's method) and its convex hull was computed with a pseudo 3D algorithm. Then, the micro-carrier volume, convex volume, open pore network, closed pore network, inner surface and throat size distribution were computed for each individual micro-carrier in wet state. This enabled accurate analysis of the statistical distribution of these parameters along samples containing tens to hundreds of micro-carriers.

To conclude, POM-based CE-CT, combined with dedicated image processing, is a highly valuable tool for 3D morphological characterization of polymeric micro-carriers in wet state.