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Plasma technology for surface modification of organ-on-a-chip devices

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The testing of new drugs since long time relies on animal models. However, the obtained test results could often not be directly transferred to humans due to differences in the physiology. The discovery of human induced pluripotent stem (iPS) cells contributes to overcome this difficulty in preclinical tests – before entering the clinical phase 0 – by allowing to test the substances in human organ models. The combination of the iPS technology with microfluidic devices is a promising technology in this field of application. Both the microphysiological environment and 3D tissue structure with its functions can be reproduced on a small dimensional scale suitable for optical investigations without further necessity of histological preparation. Same time, in a high number of identical systems can be produced which is important for parallelization and high-content-screening approaches. Examples are “heart-on-a-chip”, “retina-on-a-chip”, and “fat-on-a-chip”. These systems remain functional over multiple weeks.
The function of organ-on-a-chip systems (OoCs) is governed by multiple interfaces between different technical (polymer) materials, biological tissues, and liquid media which for instance may contain drugs, growth factors, or specific proteins. In particular in case of liquid media, care must be taken not to lose drug molecules by absorption into the building material as otherwise, the concentration profile does not remain constant and the action of drugs is falsified. The desired interface properties are therefore diverse, ranging from adhesive to non-fouling, from absorbing to barrier functions. We have developed a multilayered flexible barrier coating by plasma enhanced chemical vapor deposition (PECVD) on PDMS substrates. The coatings are effective against the permeation of small molecules as shown by permeation measurements with fluorescent dyes. Furthermore, the coatings allow for diffusion of oxygen which is substantial for cell growth in the OoCs. Furthermore, the coatings are transparent in a broad range and are free of intrinsical fluorescence which is important for all optical screening technologies.

Keywords
lab-on-a-chip
organ-on-a-chip
diffusion barrier