Scientific Paper:

Eng Life Sci. (2022) 1-13

Study on the development and integration of 3D-printed optics in small-scale productions of single-use cultivation vessels

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Abstract:

Integrating optical sensors and 3D-printed optics into single-use (SU) cultivation vessels for customized, tailor-made equipment could be a next big step in the bioreactor and screening platform development enabling online bioprocessmonitoring. Many different parameters such as pH, oxygen, carbon dioxide and optical density (OD) can be monitored more easily using online measuring instruments compared to offline sampling. Space-saving integrated sensors in combination with adapted optics such as prisms open up vastly new possibilities to precisely guide light through SUvessels. This study examines how optical prisms can be 3D-printed with a 3D-inkjet printer,modified and then evaluated in a custommade optical bench. The prisms are coated or bonded with thin cover glasses. For the examination of reflectance performance and conformity prisms are compared on the basis of measured characteristics of a conventional glass prism. In addition, the most efficient and reproducible prism geometry and modification technique is applied to a customized 3D-printed cultivation vessel. The vessel is evaluated on a commercial sensor-platform, a shake flask reader (SFR) vario, to investigate its sensing-characteristics while monitoring scattered light with the turbidity standard formazine and a cell suspension of *Saccharomyces cerevisiae* as model organism. It is demonstrated that 3D-printed prisms can be used in combination with commercial scattered light sensor-platforms to determine OD of a microbial culture and that a 3D-printed unibody design with integrated optics in a cultivation vessel is feasible. In the range of OD600 0–1.16 rel.AU a linear correlation between sensor amplitude and offline determined OD can be achieved. Thus, enabling for the first time a measurement of low cell densities with the SFR Keywords: oxygen, gradient, respiration rate, non-invasive, ramp, optical-based, sensor foil vario platform. Moreover, sensitivity is also at least three times higher compared to the commonly used method.

Keywords: 3D-printing, deepwell, individual labware, optical modification