

3D-Druck von transparenten Bauteilen zum Einsatz in (laser)optischen Strömungsmessungen

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Einführung

Ausgangssituation

- (Laser)optische Messmethoden wie *Particle Image Velocimetry (PIV)* [1,2] und *Laser Induced Fluorescence (LIF)* [3] an HSNR und in Strömungsmesstechnik allgemein erfolgreich etabliert
- Transparente Bauteile ermöglichen optische Zugänglichkeit
- Verwendung von PMMA/Acrylglas als Konstruktionsmaterial, Kombination mit brechungsindex-angepasstem Fluid → zur Vermeidung störender Lichtstreuung notwendig



Abb. 1: Rührer aus PMMA, Labor TC, HSNR

Motivation und Zielsetzung

- Komplexe Geometrien wie Rührer (siehe Abb. 1) bisher nur eingeschränkt realisierbar → Limitierung auf bestimmte Formen, optische Störungen durch Klebnähte, begrenzte Stabilität
- Neuer Ansatz: Einsatz der SLA-3D-Druck-Technologie zur Konstruktion transparenter Bauteile mit komplexen Geometrien aus Kunstharz
- Vorversuche zur Lackierung der Oberfläche sehr vielversprechend (s. Abb. 2)



Abb. 2: 3D-gedruckte Rührer, Labor TC, HSNR

Methodik

3D-Druck

- Einsatz der Stereolithographie (SLA) mit Form 3-Drucker und Material Clear Resin, Fa. Formlabs [4]
- Konstruktion von Modellen mit CAD-Software Autodesk Fusion 360 (vgl. [5])
- Anschließende Behandlung der Oberfläche durch Schleifen, Polieren und Lackieren

Einsatz verschiedener Applikationsverfahren

- Tauchverfahren
- Pinself Applikation
- Sprühverfahren

Bestimmung des optischen Brechungsindex

- Ablenkung eines Lichtstrahls an behandelte Oberfläche eines quaderförmigen Testkörpers
- Ablenken des Ausfallswinkels β bei festgelegtem Einfallswinkel α

$$n_0 = \sin \alpha / \sin \beta$$

Abb. 3: Aufbau zur Bestimmung des Brechungsindex von Festkörpern, abgelenkter Lichtstrahl durch eingezeichnete Linie gekennzeichnet, Labor Physik, HSNR



Ergebnisse und Diskussion



Abb. 4: Zylindrische Strombrecher nach Schleifen + Polieren (links), lackiert mit Pinsel (rechts)



Abb. 5: Propellerförmige, unbehandelt (links), lackiert durch Eintauchen (rechts)

Erkenntnisse

- Ursache der Nicht-Transparenz gedruckter Objekte liegt ausschließlich an der Oberfläche, während das Innere der Körper einheitlich und lichtdurchlässig ist
- Oberflächenbehandlung durch Schleifen, Polieren und Lackieren mittels Tauchverfahren (Klarlack aus Drogerie oder Baumarkt) erfolgreich
- Pinself Applikation (unebene Oberfläche) bedarf weiterer Untersuchung / Optimierung, Sprühverfahren (Bläschenbildung) nicht empfehlenswert
- Brechungsindex gedruckter Objekte konnte bestimmt werden:

$$n_0 = 1,521$$

Ausblick

- Finden eines geeigneten brechungsindex-angepassten Fluides
- Einsatz in Messungen

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[3] A. Stefan, H. J. Schultz, Use of OpenFOAM for the investigation of Mixing Time in Agitated vessels with covered Coils, in: L.M. Kubberg, M. J. Smith (Eds.), OpenFOAM, Springer International Publishing, Cham, 2019, pp. 526–526. https://doi.org/10.1007/978-3-319-40644-4_36
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