Comparison of roll-to-roll replication approaches for microfluidic and optical functions in lab-on-a-chip diagnostic devices

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ABSTRACT

Economically advantageous microfabrication technologies for lab-on-a-chip diagnostic devices substituting commonly used glass etching or injection molding processes are one of the key enablers for the emerging market of microfluidic devices. On-site detection in fields of life sciences, point of care diagnostics and environmental analysis requires compact, disposable and highly functionalized systems. Roll-to-roll production as a high volume process has become the emerging fabrication technology for integrated, complex high technology products within recent years (e.g. fuel cells). Differently functionalized polymer films enable researchers to create a new generation of lab-on-a-chip devices by combining electronic, microfluidic and optical functions in multilayer architecture.
For replication of microfluidic and optical functions via roll-to-roll production process competitive approaches are available. One of them is to imprint fluidic channels and optical structures of micro- or nanometer scale from embossing rollers into ultraviolet (UV) curable lacquers on polymer substrates. Depending on dimension, shape and quantity of those structures there are alternative manufacturing technologies for the embossing roller. Ultra-precise diamond turning, electroforming or casting polymer materials are used either for direct structuring or manufacturing of roller sleeves. Mastering methods are selected for application considering replication quality required and structure complexity. Criteria for the replication quality are surface roughness and contour accuracy. Structure complexity is evaluated by shapes producible (e.g. linear, circular) and aspect ratio. Costs for the mastering process and structure lifetime are major cost factors.
The alternative replication approaches are introduced and analyzed corresponding to the criteria presented. Advantages and drawbacks of each technology are discussed and exemplary applications are presented.

1. INTRODUCTION

2. ROLL-TO-ROLL UV-IMPRINT

3. REPLICATION APPROACHES

4. SUMMARY AND CONCLUSION

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