Adityvaus ir subtraktyvaus lazerinių mikroapdirbimų procesų panaudojimas stiklo/polimero mikrosistemoms, skirtoms cheminiam medžiagos nustatymui

Combination of additive and subtractive laser microprocessing in glass/polymer microsystems for chemical sensing applications

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Ultrashort laser pulses have enabled precise fabrication of 3D structures in fused silica by subtractive laser assisted etching (LAE) as well as additive fabrication of polymers via two-photon polymerization (2PP) [1]. Recently various types of novel applications were shown with an integration of both technologies in one device for cell sorting, counting, liquids mixing and filtering usage [2,3]. Here, we push these concepts further and demonstrate the capability of combining active mechanical deformable devices made of silica with polymer for new sensing application.

Both, the glass structure and the integrated polymer element are fabricated with a *single* Yb based femtosecond laser system (Fig. 1 (a)). First, a monolithic glass cantilever structure is produced from a single piece of fused silica by combining laser exposure and chemical etching [4]. This beam element has a low stiffness in the plane while remaining stiff for out-of-the-plane movement. Second, using a 2PP process, a polymer (SZ2080) beam is fabricated inside the gap between the deformable cantilever and the frame supporting the glass structure (as illustrated in Fig. 1 (a)). By immersing the composite micromechanical sensor into different chemicals, swelling/shrinkage phenomena of the polymer [5] is observed, causing the cantilever beam to deform. Effectively, the cantilever acts as a motion amplifier: a tiny deformation of its thinnest part is amplified and causes a sizeable motion of the cantilever tip. The composite micromechanical sensor was immersed into different liquids (4-methyl-2-pentanone, ethanol, water), which resulted instantly in different cantilever deflection angles. The observed deformations were reversible and remained the same after changing the surrounded liquid medium at least 5 cycles. Moreover, the same cantilever setup can be applied for quantitative evaluation of shrinkage/swelling forces produced by the polymer in particular during the polymerization process.

The experimental results show that such a novel concept micromechanical sensor could expand the range of active microfluidic devices, in particular to identify a given liquid medium, its concentration, as well as for the implementation of active chemical-based microactuation in lab-on-a-chip devices. In this report, we present the physical and technical background of the integration process as well as the simulated behaviour together with an experimental comparison.

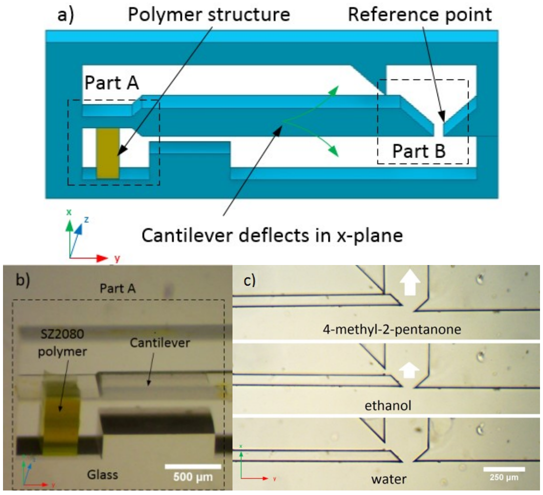

Fig. 1 a) CAD model of a cantilever fabricated out of a fused silica substrate with an integrated polymerized structure attached to it. b) Close-up view of the real structure showing the polymer attached to the cantilever, c) immersed in different liquids (4-ethyl-2-pentanone, ethanol and water), the polymer swelling/shrinkage induces a glass cantilever displacement.

Reikšminiai žodžiai: selektyvus lazerinis ėsdinimas, dvifotonė polimerizacija, subtraktyvus ir adityvus lazerinis mikroapdirbimas

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