

Amorphous silicon carbide as platform for DOEs with high and variable refractive index

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Abstract

Silicon carbide (SiC) is a unique material that exhibits high specific stiffness with a low coefficient of thermal expansion (CTE), excellent thermal stability, and advantages in mechanical resonance frequency over materials such as alumino-silicate glasses [1]. In addition to its application in high energy laser optics and as a promising material for high power electronics [2], amorphous SiC thin film coatings (a-SiC:H) provide a good opportunity to combine fused silica wafers with high refractive index a-SiC:H coatings. This opens up the possibility of using highly refractive DOEs even under harsh operating conditions [3].

The variation of the gas composition during deposition allows a linear adjustment of the refractive index in a very wide range from 1.9 to 2.6 (VIS to NIR).

The fabrication of silicon carbide devices in conjunction with the fabrication of standard silicon devices is being investigated to develop diffractive optical elements in a-SiC:H. Preliminary studies show that this combination can be an interesting and cost-effective alternative for the fabrication of high refractive index diffractive microstructures at wafer scale. We demonstrate the performance of our approach by relying on established MEMS technologies. The optical performance of the elements fabricated in a-SiC:H is compared to DOEs made of pure fused silica.

[1] Hull, T. et al., "Selection considerations between ZERODUR® and silicon carbide for dimensionally-stable spaceborne optical telescopes in two-earth-orbits", Proc. SPIE 9573, Optomechanical Engineering (2015), 95730F

[2] Johnson, J.S. et al., "Rapid fabrication of lightweight silicon-carbide mirrors", Proc. SPIE 4771, Optomechanical Design and Engineering (2002). <https://doi.org/10.1117/12.482166>

[3] Severino, A. et al., "3C-SiC film growth on Si substrates", ECS Trans. 35, 99–116 (2011). <https://doi.org/10.1149/1.3570851>