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Nanoscale investigation of two-photon polymerized microstructures with tip-enhanced Raman spectroscopy

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Abstract

We demonstrate the use of tip-enhanced Raman spectroscopy (TERS) on polymeric microstructures fabricated by two-photon polymerization direct laser writing (TPP-DLW). Compared to the signal intensity obtained in confocal Raman microscopy, a linear enhancement of almost two times is measured when using TERS. Because the probing volume is much smaller in TERS than in confocal Raman microscopy, the effective signal enhancement is estimated to be ca. 104. We obtain chemical maps of TPP microstructures using TERS with relatively short acquisition times and with high spatial resolution as defined by the metallic tip apex radius of curvature. We take advantage of this high resolution to study the homogeneity of the polymer network in TPP microstructures printed in an acrylic-based resin. We find that the polymer degree of conversion varies by about 30% within a distance of only 100 nm. The combination of high resolution topographical and chemical data delivered by TERS provides an effective analytical tool for studying TPP-DLW materials in a non-destructive way.

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Keywords

3D nano-printing, Near-field enhancement, Raman spectroscopy, Two-photon polymerization

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