**ABSTRACT**

A super-length optical needle (44 of strong transversally polarized field with homogeneous intensity along the optical axis and sub-diffraction beam size (0.48 can be generated by focusing a radially polarized beam through a dielectric interface with an annular high numerical aperture (NA) lens. Moreover, the focal shifts induced by the mismatch of the refractive indices across the interface has been found. The dependence of focal shifts and spot size of the focused field on the probe depth and NA of the objective is also analyzed in detail by numerical calculations using vector diffraction theory. Such kind of non-diffracting optical needle may have applications in atom-optical experiments, such as with atom trap and atom switches.