Measurements of Thermo-Optic Coefficients in Ta_2O_5 based micro-ring cavity

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Tantalum pentoxide (Ta_2O_5) of a large bandgap material has recently utilized to demonstrate nonlinear optical waveguide applications due to its superior linear and nonlinear optical properties [1][2], including low absorption loss coefficient in visible to infrared regions, high Kerr coefficients, and free of nonlinear absorption. In this work, the thermal-optical coefficient of tantalum pentoxide has been investigated experimentally by using a micro-ring resonator structure. Taking the advantage of index-sensitively property of ring resonator, the material with ultralow thermal-optical coefficient is easily to be measured and analyzed by using a ring waveguide structure. The cross-section of Ta_2O_5 based micro-ring resonator is set as 1.5μm*0.7μm, and the diameter of ring resonator is set as 100μm. By increasing the substrate temperature of micro-ring resonator, the variation of resonant wavelength of micro-ring resonator is recorded accordingly. The central wavelength of micro-ring resonator is red-shifted from 1543.430 nm to 1543.586 nm when the substrate temperature increases from 20 to 40°C. By considering the thermal-optical and thermal expansion effect of micro-ring resonator, the thermal-optical coefficient of Ta_2O_5 is estimated to be 6.8×10^{-6} / K at ~1550 nm. The thermal-optical coefficient of Ta_2O_5 is ten times of magnitude less than those of conventional III-V semiconductors, indicating that Ta_2O_5 supports the development of thermal-insensitive devices, such as sub-multiplexer and filter element.

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