Amorphous saturated Cerium-Tungsten-Titanium oxide nanofibers catalysts for NOx selective catalytic reaction

Herein for the first time, Ce$_{0.184}$W$_{0.071}$Ti$_{0.748}$O$_{2-\delta}$ nanofibers are prepared by electrospinning to serve as catalyst in the selective catalytic reduction (SCR) process. The addition of cerium is proven to inhibit crystallization of TiO$_2$, yielding an amorphous TiO$_x$-based solid solution stable up to 500 °C in air, with supersaturated substitutional Ce. However, at higher temperatures, anatase phase (titanium oxide) is then observed along with fluorite (cerium oxide). Tungsten is instead demonstrated to promote the reduction of the Ce$^{4+}$ to Ce$^{3+}$ with formation of oxygen vacancies ($\delta$). Catalytic experiments at the best working conditions (dry and in absence of SO$_2$) are performed to characterize the intrinsic catalytic behavior of the new catalysts. At temperature lower than 300 °C, superior NOx conversion properties of the amorphous TiO$_x$ nanofibers over the crystallized TiO$_2$ (anatase) nanofibers are observed and attributed to higher specific surface area (SSA), larger amount of oxygen vacancies, and higher amount of Ce$^{3+}$ over the Ce$^{4+}$. Comparison with literature data for ceria-tungsten-based nanoparticles also points out higher catalytic performances for the developed nanofibers at the lowest temperatures (< 300°C). This is mainly attributed to the unique nanofibrous morphology and to the doping approach. Stability of the amorphous Ce-W-TiO$_x$ nanofibers over time (120 h) and over a number of cycles (5) is demonstrated. Yet, superior catalytic performances of the developed catalysts in a wide range of temperatures (200-500 °C) over state-of-the-art material V-W-titania nanoparticles and nanofibers are also proven.