A global water crisis is on course since water demand and pollution keep increasing while many people still do not have supply of clean water. In addition, the called contaminants of emerging concern (CECs), previously undetected and thereby unregulated for many years [4], represents a great risk to human health. Therefore, the world urges for sustainable, cost-effective, and reliable methods for drinking water purification and wastewater treatments. The main purpose of this thesis is to develop a new photocatalytic membrane, based on cerium-doped zirconia (Ce-ZrO_2) on macroporous silicon carbide (SiC) supports, with improved anti-fouling and self-cleaning properties as well as able to remove contaminants of emerging concern. In the first chapter, prior to the fabrication of the photocatalytic membrane, the catalyst Ce-ZrO_2, was successfully synthesised by hydrothermal and sol-gel processes. The obtained nanoparticles were fully characterized in terms of phase composition (XRD), porosity and surface area (N_2 absorption/desorption), surface charge (zeta potential), and adsorption isotherms. In the photodegradation of humic acid (HA), a model foulant for natural and waste waters, catalyzed by Ce-ZrO_2 water dispersions, it was observed that the sol-gel prepared Ce-ZrO_2 exhibited the higher HA removal in circumneutral pH, achieving 93% of efficiency in 180 min of adsorption in the dark followed by 180 min under visible-light irradiation using light-emitting diodes (LEDs). Changes in spectral properties and in total organic carbon amounts confirmed the HA degradation and contributed to the proposal of a mechanism for the HA photodegradation. In the second chapter, Ce-ZrO_2 catalyst was immobilized through a sol-gel process on (SiC support, to increase the efficiency and avoid using suspended nanoparticles. Then, a real galvanizing industry effluent (Cr(VI)=77mg.L^{-1}, Zn=1789mg.L^{-1}) was treated. It was observed that Cr(VI) adsorption and photoreduction are greatly favoured at low pH values. HA can decrease Cr(VI) adsorption but also acts as holes scavenger, reducing the electron-hole recombination, consequently favouring the photoreduction. With the immobilized Ce-ZrO_2, more than 97% of Cr(VI) was removed from the diluted effluent. In chapter three, own to the large pores of the silicon carbide support chosen to fabricate the photocatalytic membrane, a zirconia intermediate layer was firstly deposited on the SiC support. With two dip coating-drying cycles and sintering at the optimal temperature, it was obtained a mechanically strong, homogenous, and defect free separation layer with 45 µm of thickness and average pore size of 60 nm. A pure water permeability of 360 L m^{-2} h^{-1} bar^{-1}. Owing to the membrane high hydrophilicity, in a pilot test with an olive oil/water emulsion, 99.91 % of the oil was removed without fouling. Long-term corrosion tests (21 weeks) in basic and acid baths indicated no damages (no change in the pore size) during time. In the fourth and last chapter, the photocatalytic Ce-Y-ZrO_2/TiO_2 ultrafiltration membrane was successfully prepared on the ZrO_2/SiC support using a modified sol-gel process. The 2 µm thick top active layer was uniform and defect-free, being composed of tetragonal zirconia, anatase and rutile titania. The membrane presented a molecular weight cut-off (MWCO) of 19 kDa, equivalent to an average pore size of 6 nm, and a high pure water permeability, 160 L m^{-2} h^{-1} bar^{-1}. The high hydrophilicity and negative surface charge of the membrane favoured a great retention of proteins (bovine serum albumin, whey protein, and hemoglobin), indigo dye, and humic acid. In photocatalytic experiments, the developed membrane was able to degrade phenol and humic acid under simulated sun light irradiation. In humic acid filtration tests, the membrane presented better anti-fouling properties (smaller flux decline) and higher permeate flux under irradiation compared to the filtration in the dark, as a result of the HA photodegradation and the light-induced super-hydrophilicity of the TiO_2 top layer. Moreover, self-cleaning properties were observed, as the membrane recovered up to 97% of the original flux by irradiation. Consequently, it can operate for long time without chemical cleaning, which could reduce operational costs and the process footprint.