Many toxic synthetic organic compounds including agricultural pesticides, herbicides, fuels, solvents, drugs and other potential endocrine disruptors exist in the environment, which need to be removed or destroyed to protect public health. Advanced oxidation processes (AOPs) can generate high reactive radicals at ambient temperature and atmospheric pressure; these radicals (e.g., HO•) can react with most organic compounds by undergoing addition reactions with double bonds or extracting hydrogen atoms from organic compounds. Nano-sized metal oxides have been widely used in AOPs because of the multiple valence positions as well as unique surface properties. But their catalytic applications still face two great challenges. One is the high surface energy of nanoparticles (NPs) with diameters in the low nanometer ranges often causing the undesirable agglomeration of NPs, leading to a decreased catalytic activity. The other is that some surfaces of the nanocatalysts could be covered, leading to deactivation of active sites on their surface. On the other hand, ceramic membrane has been gaining increasing acceptance for treatment of municipal and industrial waste streams. The ceramic membrane has several advantages compared to the polymeric membrane such as high thermal stability, excellent mechanical strength, good chemical inertness and insolubility in most organic solvents. The main hindrance for wide acceptance of ceramic membrane is its higher cost compared to that of polymeric membrane, although the cost has substantially decreased over the last decade. However, in view of its robust physical and mechanical properties and higher intrinsic permeability as compared to its polymer counterparts, the ceramic membrane offers several potential novel applications, whose benefits would offset its higher cost and give a better return on investment. One potential novel application is to impart a reactive functionality to the ceramic membrane, such that the membrane can function as a hybrid filtration and catalytic reactor. This can be realized through introducing nanocatalysts onto/into the ceramic membrane.