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Preface

Introduction by the guest editors

Air, water and soil pollution is presently an increasingly serious problem. Not only are new problems, such as pollutants present in ultra-microtraces being identified, but better methods are still required to cope with a wide variety of old problems associated with disinfecting water, destruction or removal of organic pollutants, and the removal of toxic metals. The supply of drinking water to isolated communities in Latin American countries is an example of an old problem that still requires better, cheaper processing. Treatment of industrial effluents, especially non-biodegradable effluents, also requires new technological options, such as the advanced oxidation processes (AOP), in which strongly oxidative species are generated, either in the bulk of the fluid to be treated, or on the surface of an adequate heterogeneous catalyst. AOPs provide a versatile battery of methods to cope with special cases of water, air and soil pollution.

This issue of Catalysis Today describes the state of the art of heterogeneous photocatalysis (HP) and homogeneous photo-Fenton (PF) in Latin America. HP is based on the use of a wide band gap semiconductor to absorb light and generate pairs of valence-band holes and conduction-band electrons. The holes may be the direct oxidative species, or alternatively, they may give rise to $OH^{\bullet}$ radicals, as in several other AOPs. PF is provoked by means of the addition of H_2O_2 to Fe^{2+} salts and by irradiation with UV-Vis light. Under these conditions, the photolysis of Fe^{3+} complexes allows Fe^{2+} regeneration and iron may be considered a true catalyst. This is another simple way of producing $OH^{\bullet}$ radicals. Both processes are of special interest since sunlight can be used for them.

One of the crucial issues in HP is the need for a stable, cheap and efficient photocatalyst that can convert incident radiation into surface (h^{+}_{vb}–e^{-}_{cb}) pairs, with high yields and low recombination rates. In its more ambitious form, the use of solar radiation is sought, and therefore the position of the band edge in the catalyst is of paramount importance to permit the use of tail UV radiation and even of visible light. Efficient use of incident radiation implies a need for efficient hole scavenging at the surface, either by surface –OH groups or by adsorbed molecules. The relationships between photo-oxidation rates and between surface structure and composition, defined in part by intrinsic properties of the catalyst and in part by the chemisorption of pollutants, intermediates and products, are still not fully understood.

Until now, the catalyst that best suits the required characteristics is anatase titanium dioxide. This is an n-type semiconductor, and one of its limitations is the relatively slow rate of capture of the majority carriers (electrons) by the oxidant involved in the catalytic process (oxygen reduction has a high overvoltage on TiO_2). In an attempt to circumvent this problem, different approaches, such as doping the catalyst, partially coating its surface with a metal, etc., have been studied. A second important point refers to the non-specificity of total mineralisation, i.e., the conversion of all organic pollutants into carbon dioxide, water, and inorganic species derived from the heteroatoms. This implies required characterisation of intermediates built up and destroyed, and simple measurements of residual total organic carbon (TOC) are often insufficient to guarantee successful decontamination. In this sense, measurement of residual toxicity is an interesting alternative, which provides a guide as to when the liquid is ready for biological treatment. Even though the emphasis is on the decontamination of water containing organic pollutants, the method is also potentially apt for depolluting air. It is also

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useful in the removal of metal ions, as it promotes prior oxidation or reduction, thereby generating more easily removable species.

Many of the research teams that have published their results in this special issue are members of the Ibero-American Network on Heterogeneous Photocatalysis. This network (Red CYTED VIII-G), formed by the Ibero-American Co-operation Program on Science and Technology (CYTED), has enabled strong co-operative links to be established in the region. The network presently includes groups from Argentina, Brazil, Chile, Colombia, Cuba, Mexico, Peru, Spain and Uruguay. In all, 23 groups participate. An interesting outcome of this co-operation has been the publication of an anthology entitled *Eliminación de Contaminantes por Fotocatálisis Heterogénea*, the first in its field available in Spanish. It describes the principles of photocatalysis (basic mechanisms, catalyst preparation and properties, design of photocatalytic reactors, HP in water and air depollution, photocatalysis using an anodically polarised photocatalytic electrode, removal of metals) and provides examples of practical applications (treatment of pesticide residues, textile industry effluents, conventional effluents from nuclear power plants, and water disinfecting). The book is available on the Internet at http://www.cnea.gov.ar/cyted/default.htm and on CD-ROM from M.A. Blesa upon request. The network has also supported Summer Seminars and Workshops in various countries in the region. The Ibero-American course on photocatalysis recently organised (June 2002) in Seville was attended by around 35 students, nearly half of whom were from Latin American countries. Co-operation has also resulted in several regional and other joint research projects under the auspices of the European Union (UE) and the Organisation of American States (OEA). These projects focus on the development of processes to provide quality drinking water to isolated communities in Ibero-America, one of the serious challenges faced by these countries in their quest for better socio-economic conditions.

Twenty papers are presented here, involving 25 research institutions from eight Ibero-American countries (Argentina, Brazil, Chile, Colombia, España, México, Perú, Venezuela). The work included can be classified into the following main themes: (a) catalysts preparation and testing, (b) photo-Fenton, (c) solar photocatalysis, (d) development of kinetic models for interpretation of experimental results, (e) determination of reaction pathways (f) gas-phase photocatalysis, (g) combination of biological and photocatalytic methods and (h) electrophotocatalysis.

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