Gel Route to Early Transition Metal Oxides

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Transition metal oxide gels have been known for almost a century [1,2], but have only recently gained applications in materials processing. Traditionally, ceramics and glass have been made utilizing methods involving high temperatures. During the last decade, however, the Sol-Gel process for making glass and ceramics has gained importance. The gel route allows low temperature processing and is suitable for dip-coating and fiber drawing [3]. Some of the current industrial applications of the Sol-Gel process include antireflection coatings, sunshielding windows and coating on automobile rear view mirrors [4].

Transition metal oxide gels can be obtained by hydrolysis and condensation of metal alkoxides [5,6] or by acidification of aqueous inorganic salts [7,8]. The Sol-Gel process thus essentially involves the transformation of a <u>sol</u> or solution to a solid network of polymers or agglomeration of particles in a liquid called a <u>gel</u>. The gels are then heated below the melting temperature of the oxides to form glass or ceramics [9,10].

Transition metal oxides with their useful range of ionic and electronic properties may find wide applications in the electronics industry. These transition metal oxides are often mixed valence compounds and the metal ion may exhibit several oxidation states. This leads to useful electrical and optical properties such as semiconducting WO_3 [11] or V_2O_5 [12] gels and electrochromic WO_3 or MoO_3 films [13]. Transition metal oxide gels can also be considered as hydrated oxides with characteristic ionic properties arising from the water molecules trapped in the gel. Some hydrous oxides thus show high proton conductivity at room temperature and may behave as inorganic ion exchangers [14].

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