

## REPLY TO THE COMMENT BY J.T. KLOPROGGE, J.A. ROB VAN VEEN, E. BOOIJ, AND RAY L. FROST ON “ENHANCED THERMAL STABILITY OF Al-PILLARED SMECTITES MODIFIED WITH Ce AND La”

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Valverde *et al.* (2000) recently reported on the preparation and characterization of Al-pillared smectites modified with Ce and La. The purpose of this work was to study the influence of Ce or La in Al-pillared clays on the thermal and the hydrothermal stability of these materials, previously not studied extensively. In addition, the physicochemical properties of Al-pillared clays modified with Ce or La were investigated using two bentonites.

The structure of these materials was studied by X-ray diffraction. Isotherms were determined by N<sub>2</sub> adsorption. Thermal stability was determined using thermogravimetric (TG) measurements and ammonia-TPD (temperature programmed desorption) was used to obtain acidity data. In addition, the effect of heating temperature on the untreated clay and derived pillared clays was characterized using infrared spectroscopy.

We concluded that (1) Pillared clays modified with Ce or La did not show any apparent structural changes relative to the Al-pillared clays; (2) Pillared clays modified with Ce and La had similar acid properties to Al-pillared clays; (3) In contrast, the thermal and hydrothermal stabilities of these materials were greater than Al-pillared clays. However, Ce-pillared clay appears to be more effective than La-pillared clay in delaying the dehydroxylation of pillared clays with increasing temperature; and (4) The intercalation of Ce and La into Al-pillared clays improved thermal stability, which may increase the utility of these materials as catalysts.

We agree with Klopogge *et al.* (2001) that there are several papers reporting the preparation of thermally stable pillared clays (McCauley, 1988; Sterte 1991a, 1991b, Booiij *et al.*, 1996a, 1996b) and we thank them for bringing our attention to earlier papers (Klopogge *et al.*, 1994; Klopogge, 1998) suggesting that “the relatively low micropore volume can probably be explained by the incorporation of a relatively large amount of Ce or La in the interlayer between the pillars during the synthesis of the pillared clays where initial REE/Al ratios of  $\leq 1.8$  were maintained” (Klopogge *et al.*, 2001).

However, although the general discussion on the infrared spectra based on early papers (Brydon and Kodama, 1966; Teagarden *et al.*, 1981; Goh and Huang, 1986; Occelli and Finseth, 1986; Klopogge *et al.*, 1992, 1999; Michot *et al.*, 1993; Chevalier *et al.*, 1994; Klopogge and Frost, 1998, 1999) is exhaustive, we have no way to verify and confirm the presence of some of the bands with our present equipment, especially the stretching modes at  $\sim 3500$  cm<sup>-1</sup>. This problem is attributed to the lack of sensitivity of our present Fourier-transform infrared device. This problem will be resolved shortly with the acquisition of a new system with a reaction chamber.

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