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Metal Nanoparticles: *In-Situ* Stabilization, Characterization and Reactivities

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We report here, the technique for preparation, characterization and reactivities of different metals (Cu, Ni, Au, Ru, Pt etc.) nanoparticles. The stabilized metal nanoparticles are, in general, very active as catalysts, e.g., hydrogenation (with H_2/transfer hydrogenation) of nitro to amino group, ketone to alcohol and also oxidation of alcohol to Ketone/aldehyde. Metal nanoparticles, due to their smaller size than bacteria, tissues etc. and high reactivities, must have high impact on safety, health and environment and therefore, a systematic study of the effect of metal nanoparticles in these aspects need be carried out.

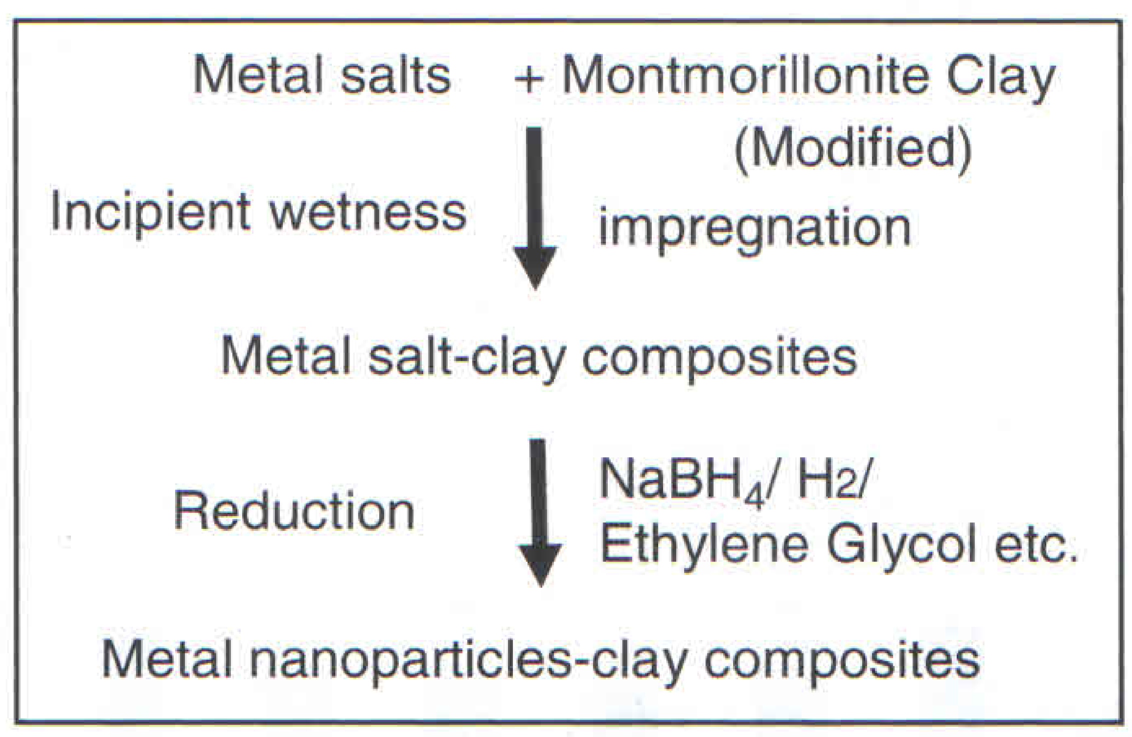
Keywords: Metal Nanoparticles, Mont-Morillonite, Hydrogenation, Oxidation.

1. INTRODUCTION

Metal nanoparticles of size less than 10 nm having high surface-to-volume ratio have attracted great attention in recent time for their potential applications in the fields of catalysis, drug delivery, sensors, abatement of pollution etc.[1–5] We report here, the technique for preparation, characterization and reactivities of different metals (Cu, Ni, Au, Ru, Pt etc.) nanoparticles.

2. MATERIALS AND METHODS

Metal nanoparticles stabilized on acid activated Montmorillonite (modified) clay have been synthesized *in situ* by the reduction of respective metal salts impregnated clay samples with reducing agents like $NaBH_4$, sodium citrate, ethylene glycol, H_2, hydrazine etc. having a metal loading in the range 0.5 to 1 mmol g^{-1}. A general preparation technique is shown in Scheme 1.



Scheme 1. Synthesis of NP-clay composites.

3. RESULTS AND DISCUSSION

The surface area data (BET) reveal that after loading with Cu°-nanoparticles, as a typical example, the surface area is reduced from 680 to 307 m^2/g indicating that the metal nanoparticles occupy the possible pores of the modified clay matrix, which is also substantiated by decrease of the pore volume from 0.69 to 0.40 cc/g. This observation is

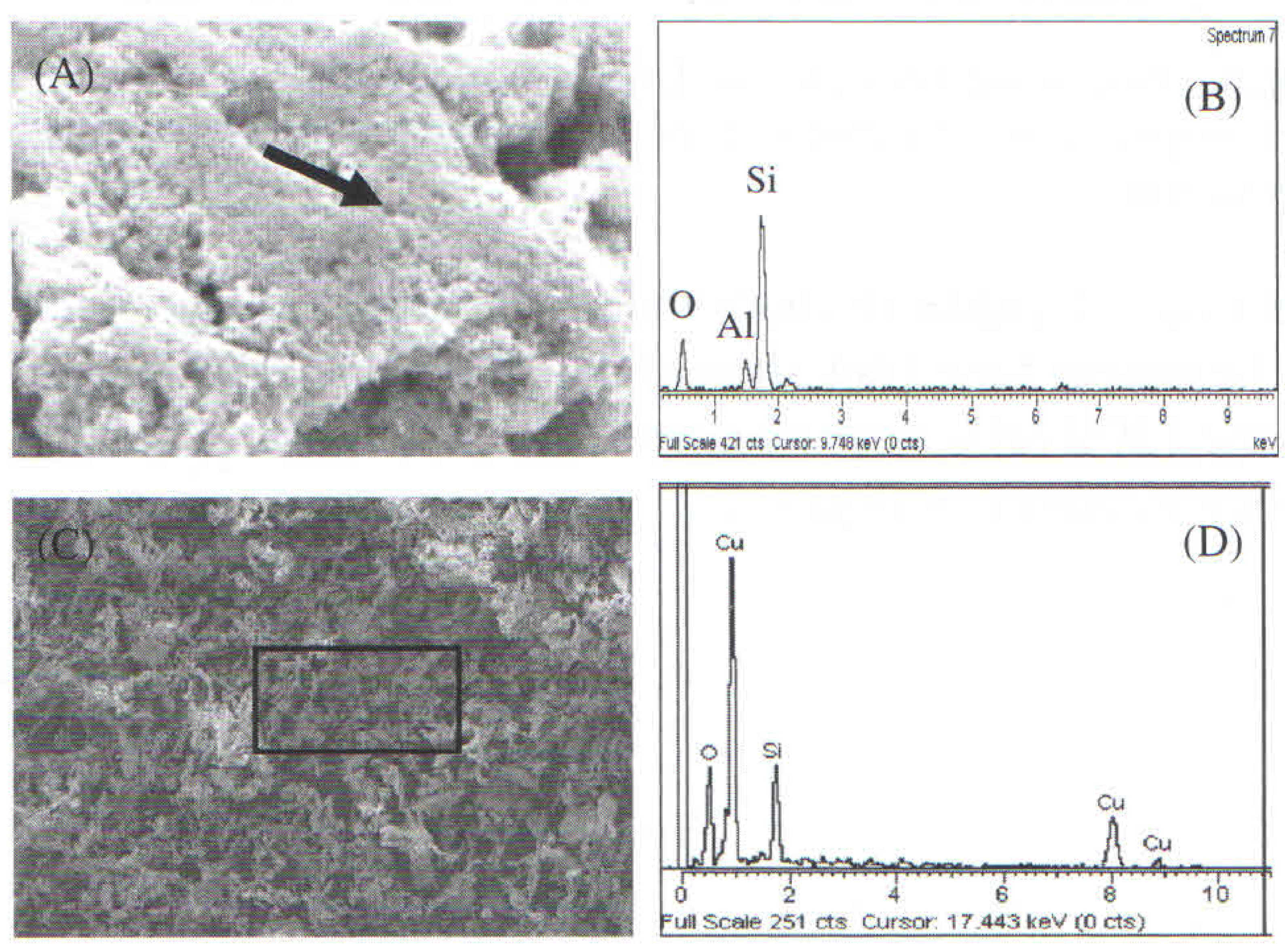


Fig. 1. SEM-EDX (A) and (B) of Modified clay; (C) and (D) of Cu°-nanoparticles-clay composites.

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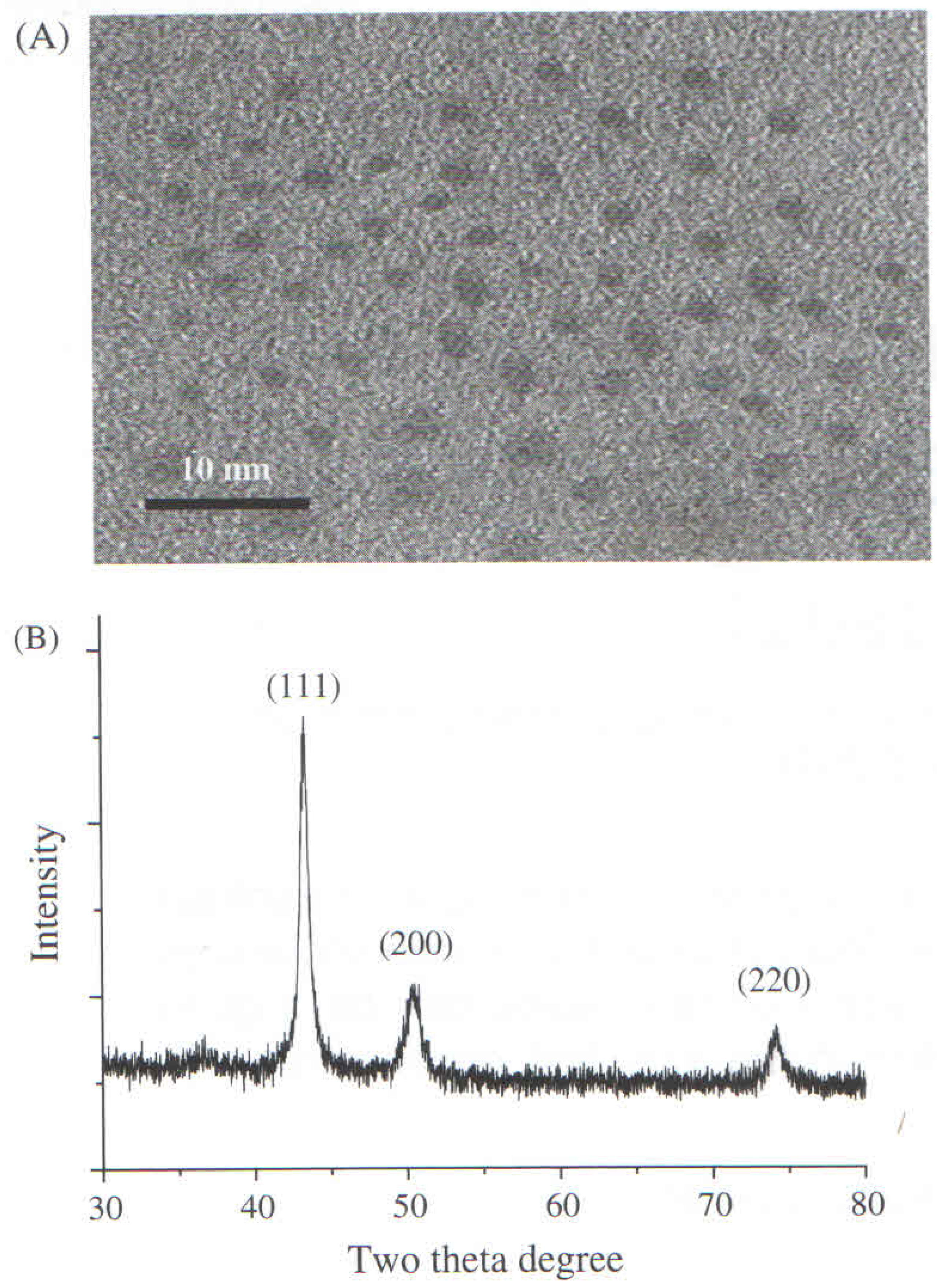

Fig. 2. (A) TEM image and (B) XRD pattern of Cu°-nanoparticles-clay composites.

further substantiated by the SEM-EDX (Fig. 1) where the unloaded acid activated clay matrix exhibits porous structures (Fig. 1(A)) consisting mainly of silica (Fig. 1(B)), while in the clay supported Cu°-nanoparticles, the pores are loaded with metal particles as evidenced by SEM-EDX (Figs. 1(C, D)). A typical TEM reveals (Fig. 2(A)) that most of the Cu°-nanoparticles are less than 5 nm. The XRD study (Fig. 2(B)) reveals a Face Center Cubic (FCC) lattice structure of the Cu°-nanoparticles. The metal nanoparticles-clay composites are, in general, stable up to about 300 °C.

The stabilized metal nanoparticles are, in general, very active as catalysts, e.g., hydrogenation (with H_2/transfer hydrogenation) of nitro to amino group, ketone to alcohol and also oxidation of alcohol to Ketone/aldehyde.

Metal nanoparticles, due to their smaller size than bacteria, tissues etc. and high reactivities, must have high impact on safety, health and environment and therefore, a systematic study of the effect of metal nanoparticles in these aspects need be carried out.

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References and Notes

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