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Influence of surfactants on the stability and physicochemical properties of nanofluids

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Abstract – In this study nanofluids were prepared by one-step method, using sodium hypophosphite as reducing agent in ethylene glycol base fluid. In order to maintain the stability of nanofluids, different protective molecules were used: polyvinyl pirrolidone (PVP) and sodium lauryl sulphate (SLS). X-ray diffraction (XRD) and transmission electron microscopy (TEM) studies provided structural and morphological characteristics of the produced nanofluids particles. Complementary Fourier transform infra-red (FT-IR) analysis and Differential scanning calorimetry (DSC) measurements of thermal conductivity were carried out.

The research in heat transfer field has received a great boost and a renewed interest in recent years because of the increasing demand of cooling systems with more efficient heat exchange capacity. Two main approaches to increase the cooling efficiency can be pointed out: the introduction of new geometries in cooling systems and the increase of the exchange capacity of the fluids used in thermal systems. In many cases, however, the constructive restrictions make impossible the use of geometrical factor to increase the heat removal from the system. In contrast, the heat exchange property of a refrigerant can be considerably improved without affecting the geometry of the whole system by introducing in the fluid medium particles with high thermal conductivity. In the past, this approach was tested using refrigerants with particles of micrometric size or greater. This led to unsatisfactory results due to the various phenomena encountered in such fluids: rapid sedimentation of suspensions, erosion of heat exchange devices and products, obstruction of pipes, high-pressure loss, etc. Recent results showed, however, that the addition of nanometric size particles in refrigerants can increase considerably the thermal conductivity of fluids, with maintained stability [1]. To characterize the produced nanofluids, XRD and TEM measurements have been carried out. The powder diffraction patterns revealed the formation of two phases: Cu and Cu_2O in all studied fluids (see figure 1). The convolution based approach to full powder pattern refinement (Rietveld fit) [2] has been used to extract the average structural and microstructural (strain, crystallite size) parameters of Cu crystallites. The particles size and shape were also evaluated by TEM (figure 2). Both, XRD and TEM data analyses showed a good agreement. The nanofluid prepared using PVP had greater stability and better thermal properties among all those studied.

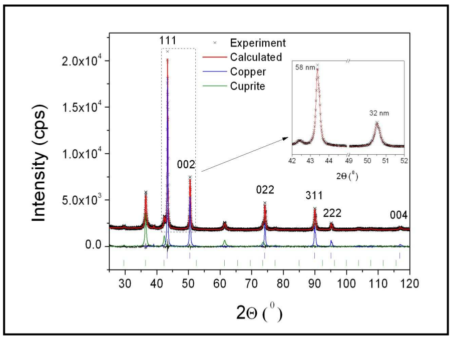

Figure 1: Experimental (crosses) and convolution-based profile fitted (red line) XRD patterns. The difference curve is shown at the bottom. Single-phase diffraction patterns of Cu (blue line) and Cu_2O (olive line) are shown. The average volume weighted thicknesses of the crystallites are shown in inset.

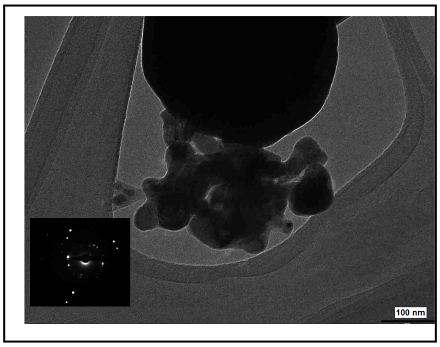

Figure 2: TEM image of nanofluid Cu + PVP particles. The inset shows the electron diffraction pattern from dispersed particles.

References

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[2] A. A. Coelho. TOPAS-Academic Users Manual. http://members.optusnet.com.au/ ~alancoelho/.