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Fluorescent Magnetic Nanofluids Based on Ferrofluids and Carbon Nanodots

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Abstract: Ferrofluids (FFs) and Carbon Nanodots (CDs) have been gathering worldwide attention due to their broad range of applications as promising solutions to many current global issues. In this study, we introduce an innovative fluorescent magnetic nanofluid (FMN) synthesized [1] by combining aqueous FFs based on core@shell $CoFe_2O_4$@γ-Fe_2O_3 magnetic nanoparticles (MNPs) [2] with fluorescent nitrogen-rich carbon nanodots (N-CDs) [3,4]. The hybrid nanofluid was investigated in acidic (pH ~ 2.5) and neutral (pH ~ 7.0) conditions, allowing us to probe the effects of different interparticle interactions in the colloidal stability. In acidic regime, the fluid is unstable as macroscopic phase separations were observed with and without the presence of an applied magnetic field. On the other hand, in neutral conditions (in which an additional citrate coating of the MNPs is required) the FMN is visually homogeneous, even under field. The observed macroscopic stability was further confirmed at smaller scales by optical microscopy and small angle X-ray scattering (SAXS). In addition, the magnetic properties of the stable FMN were checked in a wide range of temperatures and magnetic fields, in which no significant changes were observed comparing to pristine FF. Nonetheless, the FMN fluorescence emission was considerably modified by the presence of the MNPs, if compared with N-CDs alone. The reduction of the fluorescence emission was mostly attributed to optical absorption and quenching effects. These results demonstrate that in controlled conditions a stable FMN can be achieved by mixing FFs and CDs, while largely preserving individual properties of each nanocomponent. For this reason, the presented hybrid multifunctional fluid successfully combines highly appealing assets into a single product showing a substantial potential for technological applications.

Key-words: ferrofluids; carbon dots; fluorescent liquids
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