REVIEW OF METHODS ASSOCIATED WITH LANTHANOID SOAP FORMATION

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Abstract

These lanthanide (III) soaps have attracted the attention of industrial laboratories due to, among other things, their catalytic capabilities. Metal soaps can exhibit catalytic activity at the transition between an aqueous and an organic phase due to their amphiphilic character. The discovered chemicals, such as Cerium (III), Lanthanides (III), and Neodymium, offer a wide range of applications in catalytic systems. This review gives an outline of the processes involved in producing lanthanoid soap.

Keywords : Lanthanoids, Transition Metals, Cerium (III), Lanthanides (III), Alkali Salts

Introduction

"Soap" is an alkanoic acid that contains salts of sodium or potassium, such as potassium stearate (potassium octadecanoate), and long aliphatic fatty acid chains. Since they dissolve in water, soaps have been used for ages to clean clothes and care for bodies. The so-called "metal soaps" are fatty acid salts that are distinct from alkali soaps. These are mixtures of transition metals or group IIIa elements with earth alkaline. Metal soaps can be dissolved in organic solvents but are not soluble in water. Additionally, these chemicals have specific qualities that make them beneficial in some situations. The alkali salts of fatty acids, which are composed of five carboxylic acids with lengthy alkyl chains, are well-known as soaps. In water, these soaps disintegrate. When an alkali ion is replaced in higher homologues by an alkaline earth or a transition metal ion, the resulting compounds are less soluble in water but more soluble in non-polar organic solvents. Alkaline earth and fatty acid salts of transition metals make up the so-called metal soaps.[1,2] Lanthanides and rare earths in general can also result in the development of metal soaps. The typical formula for these substances is $Ln(C_nH_{2n+1}COO)_3$.[3,4] Although there are a number of research on lanthanide soaps in solution in the literature.[5-11] The lanthanide soaps are used extensively across a number of sectors and are crucial to surface chemistry. Studies on these soaps are very important for describing properties under various situations and for their applications in industries. While significant advancements have been made in the research of transition metal soaps, alkali, and alkaline earth. In this article, the procedures related to lanthanoid soap manufacture have been discussed.

Methods Associated with Lanthanoid Soap Formation

Neodymium Soaps in Methanol[12]

Neodymium butyrate, valerate, and caproate serve as simple electrolytes in diluted solutions, and it was found that the CMC decreased with an increase in the length of the fatty acid chain in the soap molecule.In order to calculate the CMC, degree of dissociation, and dissociation constant of neodymium soaps in methanol,[12] conductometric tests were used. The equations proposed by Einstein, Vand, Moulik, Jones, and Dole serve as a foundation for this the viscosity results have been explained. Einstein's equation and Vand's equation get the same results for the molar volume values.

Sodium Dodecyl Sulfate Micelles

Trivalent lanthanides have been investigated for their interactions with sodium dodecyl sulphate micelles (SDS) in aqueous solution using a variety of experimental techniques. Potentiometric measurements using a sodium-selective electrode, steady-state fluorescence spectra of Ce(III), emission lifetime measurements of Ce(III), Tb(III), and Eu(III), and electronic paramagnetic resonance spectra (EPR) of Gd(III) all show that the lanthanide ions bind to the micellar surface.[13]

Cerium (III) alkanoates

the creation, description, and thermal properties of cerium(III) alkanoates. The mixture of the chemicals is $[Ce(C_xH_{2x+1}COO)_3]$.[14] It was discovered using infrared spectroscopy and by comparing the results with data from single crystals for related compounds that the compounds include different types of cerium-carboxylate ion coordination and that the all-trans conformation of the alkyl chain exists. While a mesophase M is also present for the shorter homologues at lower temperatures, hot-stage optical polarised microscopy and X-ray diffraction at high temperatures were utilised to identify a lamellar mesophase as a smectic A phase.

Cerium (III) Caprylate

It was possible to ascertain the corresponding values of the critical micelle concentration, CMC, of cerium(III) caprylate in the solvent mixtures of 70/30 and 50/50 (v/v) methanol-benzene by observing the inflexion displayed by the plots of physical properties (namely conductivity, density, viscosity, and ultrasonic velocity) versus soap concentration, C. (4.9 x and 3.3 x 10-4 M).[15]

Lanthanide(III) Dodecanoates

The new investigation confirms previous findings about Ce^{III} and La^{III} carboxylates' thermal and structural properties, but it is unexpected and a little shocking that a SmA mesophase was only seen for the larger lanthanides La^{III} and Nd^{III}. Lanthanide(III) dodecanoates illustrate that even tiny changes in ionic radius between the lanthanide ions are critical for the production or absence of a mesophase, despite the fact that Schiff-base complexes have showed a decrease in the mesophase stability ranges over the lanthanide series.[16]

Neodymium Soaps in 1-Pentanol

The optical absorption spectra of neodymium(III) butanoate, pentanoate, hexanoate, heptanoate, and octanoate in 1-pentanol have been measured.17 The selected solvent is effective at solubilizing the neodymium(III) soaps. A set of free-ion parameters are produced by fitting the estimated energy levels against the experimental data. The V6 parameter does not differ significantly between the butanoate and pentanoate complexes when compared to the higher homologues of the neodymium(III) soaps.

Lanthanide Elements

Mesomorphic lanthanide(III) complexes with salicylaldimine as the ligand have been produced. Variations in the structure of the ligand framework, the amount of alkoxy chains, and the counter-anion are explored along with their impact on the mesomorphic behaviour. Complexes that exhibit columnar or smectic mesophases have been achieved.[18]

Lanthanide Metal Oleates

Lanthanide (La, Ce, and Nd) oleate dissociation and micellization processes: thermodynamic variables, critical micelle concentration, dissociation level, and dissociation constant A mixture of 60% benzene and 40% methanol was looked at using the conductivity data. The results showed that these soaps only function as weak electrolytes. The values of the cmc increase as the temperature rises in diluted solutions.[19]

Lanthanide Soaps

Research on the infrared spectrum of lanthanide soaps (octanoates of cerium, didymium, neodymium, and samarium) reveals that the metal-to-oxygen connections in these soaps are ionic, while the fatty acids exist with a dimeric-type structure due to hydrogen bonding between two molecules of fatty acids.9 According to the X-ray diffraction results, these soaps have a double-layer structure with molecular axes that are moderately inclined to the basal plane. The premicellar association and the emergence of micelles in lanthanide soap solutions have been investigated using conductometric analysis in a nonaqueous medium.

Cerium (III) Alkanoates

The ultrasonic investigations have established the critical micelle concentrations (CMC) of cerium(III) soaps (hexanoate, octanoate, and decanoate) in benzene-methanol mixture (50% v/v).[20] The fatty acid chain length of the soap molecule's component grows longer, CMC values decrease. These soaps' varied acoustic characteristics have been assessed using measurements of ultrasonic velocity.

Lanthanum(III) alkanoates

The mesophase behaviour of the lanthanum(III) alkanoates has been investigated using high-temperature X-ray diffraction, differential scanning calorimetry, and hot-stage polarising optical microscopy.21 The remaining lanthanum(III) butyrate monohydrate short chain homologues (x5 4-9) show a highly viscous mesophase M and a smectic A phase. Mesomorphism is not present in the monohydrate of lanthanum(III) butyrate. Longer chain length (x5 10-19) lanthanum(III) soaps only exhibit a smectic A phase.

Lanthanide Phytanates

Phytanic acid is an isoprenoid-type amphiphile that has been synthesised and given lanthanide salts. Elemental analysis and FTIR spectroscopy were used to confirm the generated product, and they showed that three phytanate anions are complexed with one lanthanide cation.22 Many of the hydrated salts can form a liquid-crystalline hexagonal columnar mesophase at normal temperature; samarium(III) phytanate can even accomplish this without water. Several lanthanide phytanates were dispersed in water, and Cryo-TEM pictures reveal that some structure has been maintained in the scattered phase. NMR relativity measurements were performed on these apparatuses.

Alkoxy Mixed-Ligand Soaps

Tris derivatives made of lanthanides that are insoluble in water are created when they are combined with fatty acids like lauric, palmitic, and stearic acid. Lanthanide alkoxides react with these fatty acids in various stoichiometric ratios to make alkoxy mixed-ligand soaps of the types [Ln(OR)(A)(A')], [Ln(A)(A')], and [Ln(OR)z(A)], where A, A', and A'' are the three different fatty acids. The reactions of Ln(OR)(A)(A') and Ln(OR)2(A) with acetyl chloride and acetyl bromide, respectively, result in the lanthanide chloride- or bromide-mixed soaps.23 These Pr(III) and Nd(III) alkoxide, chloride, bromide, and quaternary-mixed soaps' absorption spectra were analysed using the Judd-Ofelt theory, and the spectral parameters were calculated using regression analysis.

Conclusion

Although lanthanide (III) soaps have a wide range of applications, How little fundamental study has been done on the physicochemical properties of these lanthanide soaps is remarkable. Lanthanide soaps have received some attention in recent years, while the majority of the studies have focused on complexes that have been investigated in solution by evaluating the threshold micelle concentration and viscosity. The substances, like Cerium (III), Lanthanides (III), and Neodymium, are widely used in catalytic systems. The overview of procedures related to the production of lanthanoid soap is provided in this review.

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