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Surveying the effects of silver nanoparticle on thermal properties of some calyx [4]arene compounds by Differential Scanning Calorimetry (DSC)

S. Hedayati[1,*]
A. Hassanzadeh[2]
B. Shaabani[3]
M. Alem[1]
E. Hobbolahi[1]

[1] Chemistry Department, Islamic Azad University-Ardabil Branch, Ardabil, Iran
[2] Chemistry Department, Urmia University, Urmia, Iran
[3] Chemistry Department, Tabriz ,University, Tabriz, Iran

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ABSTRACT

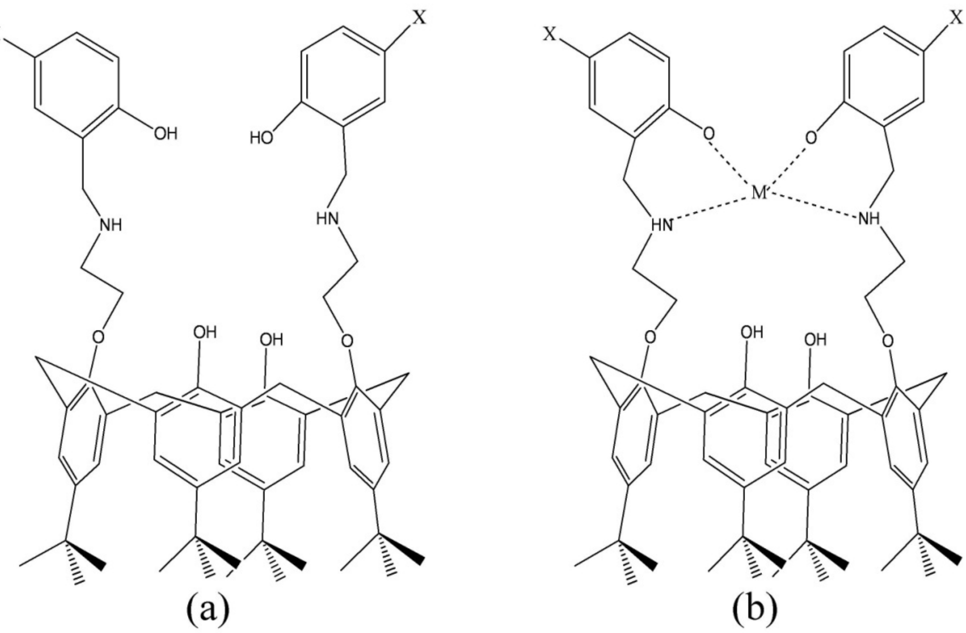
One of the best and the most active ways for surveying thermal behaviour of materials is using differential scanning calorimetry. In this paper, the authors have studied thermal behaviour for Schiff base ligand and their synthesized Cobalt, Nickel complexes. In this method, the sample is opposed to a controlled temperature change and its physical properties. Here we studied melting point and T_g and thermal destructive by surveying DSC thermograms of above compounds. Our team also have surveyed thermograms from the mix of these compounds with nano silver.

Keywords: *Nanosilver, Differential Scanning Calorimetry (DSC), Calyx[4]arene, Schiff base*

INTRODUCTION

Nanotechnology, which shortened to "nanotech", is the study of the controlling of matter on an atomic and molecular scale. Generally nanotechnology deals with structures sized between 1 to 100 nanometer in at least one dimension, and involves developing materials or devices within that size. There has been much debate on the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in medicine, electronics, biomaterials and energy production. On the other hand, nanotechnology raises many of the same issues as with any introduction of new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. In nanotechnology, a particle is defined as a small object that behaves as a whole unit in terms of its transport and properties. It is further classified according to size: in terms of diameter, fine

*Corresponding author:
Sanaz Hedayati
Chemistry Department, Islamic Azad University-Ardabil Branch, Ardabil, Iran
Tel +98 443 5225488
Fax +98 443 5238472
Email msc_hedayati@yahoo.com



Scheme.1. Chemical structure of calyx [4]arene compounds(a) ligand, (b) complex

particles cover a range between 100 and 2500 nanometers, while ultrafine particles, on the other hand, are sized between 1 and 100 nanometers. Similar to ultrafine particles, nanoparticles are sized between 1 and 100 nanometers. Nanoparticle research is currently an area of intense scientific interest due to a wide variety of potential applications in biomedical, optical and electronic fields. Silver Nano (Silver Nano Health System) is a trademark name of an antibacterial technology which uses silver nanoparticles in washing machines, refrigerators, air conditioners andair purifiers.

In this work, we also tested the thermal behaviour for Schiff base ligands and their synthesized Cobalt and Nickel compounds. Using Differential scanning calorimetry (DSC), we observed melting peak and thermal destruction of these compounds in obtained thermograms. Considering the obtained thermograms from the mix of these compounds with nano silver and comparing the melting peak and thermal destruction available in pure thermograms of these two materials, we understood the thermal properties of calyx [4]arene compounds.

MATERIALS AND METHODS

p-t-butylcalyx[4]arenes were prepared as following the previously reported method [1]. The Chemical structure of calyx [4]arene compounds used in this study are shown in Scheme 1. Thermal analysis of calyx [4]arene compounds were performed using Differential Scanning Calorimetry (DSC). The DSC analyses were performed under N_2 condition. A DSC – 823 Differential Scanning Calorimeter of Mettler Toledo was used. The temperature program of DSC was as follows: the initial and final temperatures were 25 °C and 500°C respectively, and the heating rate was 10°C min^{-1}. All small pieces of compounds were placed in aluminium pan[2-5].

RESULTS AND DISCUSSION

DSC thermal analysis was performed on reduced compounds. Heating the above mentioned ligands, a glass transition which was due to the amorphy property of the ligands had been observed. To make this phase transfer more clear, also took the heating-cooling thermogram at which during the re-heating stage of the glass transition of discussed ligands, it can be clearly observed and it proves the

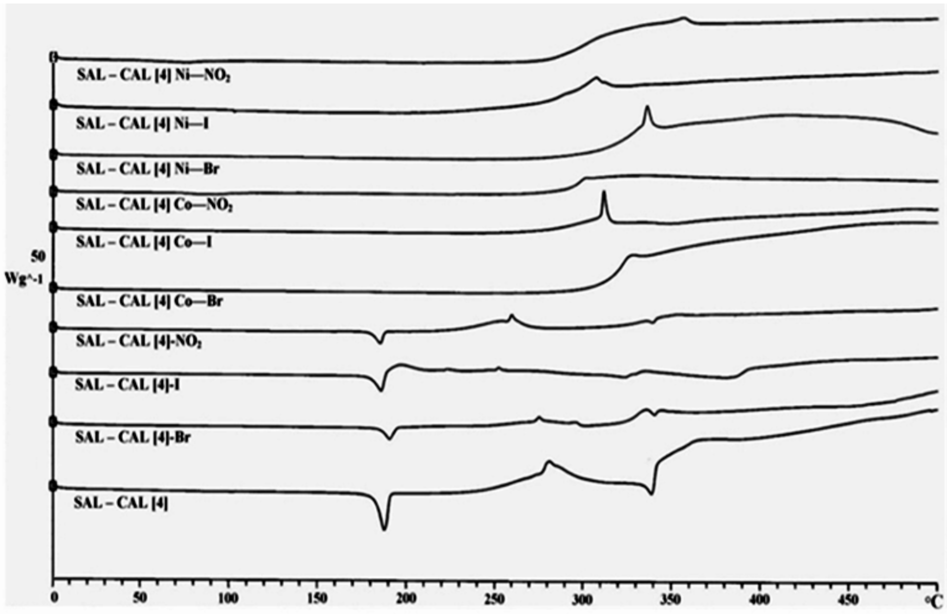


Fig.1. Differential Scanning Calorimetry (DSC) trace of pure Sal-cal[4] (down), Sal-cal[4]-Br, Sal-cal[4]-I, Sal-cal[4]-NO_2 ligands and Sal-cal[4]-Co-Br, Sal-cal[4]-Co-I, Sal-cal[4]-Co-NO_2, Sal-cal[4]-Ni-Br, Sal-cal[4]-Ni-I, and Sal-cal [4]-Ni-NO_2 complexes (top) with heating rate10°C/min.

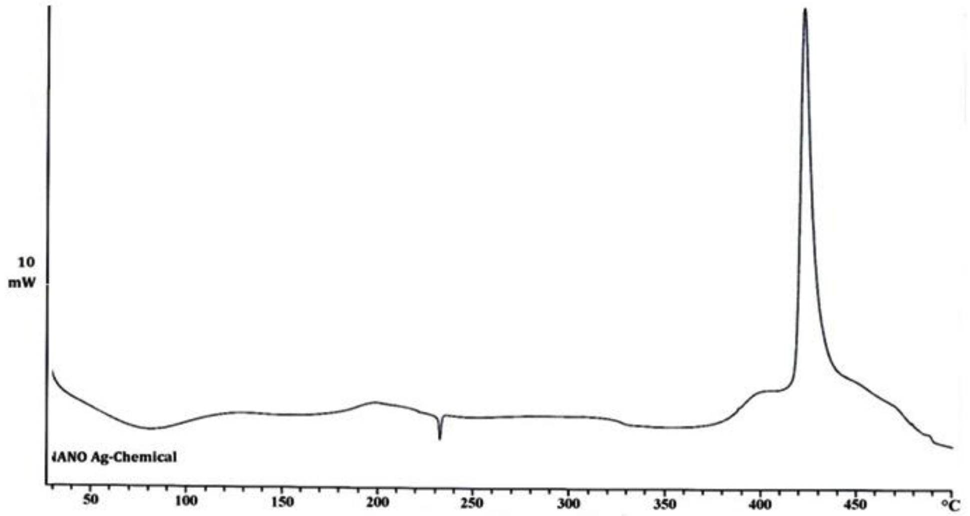


Fig.2. Differential scanning calorimetry (DSC) traces of silver nanoparticle with heating rate 10 °C/min

amorphy property of the ligands. Increasing the temperature of the sample, a sharp endothermic peak for the melting process of the ligand was observed. These two peaks are not observed in the DSC thermograms of complexes. By further increasing the temperature, the DSC thermograms, shows another important peak at about 280°C (for ligands) and at about 315°C (for complexes) corresponding to the thermal decomposition of these compounds (Figure 1).

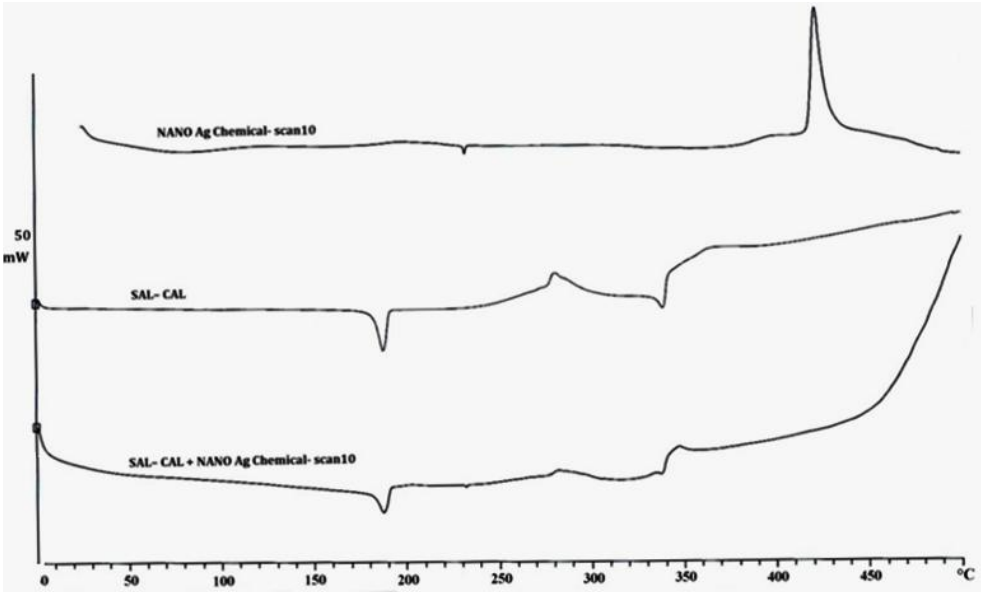


Fig.3. DSC thermograms of calyx [4]arene ligands and from mixing Ag nanoparticle and these ligand at a heating rate of 10°Cmin-1

Figure 2 shows the DSC trace of silver nanoparticle, with heating scan rate 10°C/min.Two obvious peaks were obtained. The peak temperature of the first endothermal peak is 230.41°C which correspond to the melting point of Ag nanoparticle. The peak temperature of the second exothermal peak is 421.99°C. This is thermal destruction of the silver nanoparticle. For silver nanoparticle + sal - cal [4] formulation, two broaden endothermic melting peaks had been observed. One of these peaks, is close to that of silver nanoparticle and the other one to that of pure sal – cal [4]calyxareneligands. As it can be seen, the exothermic decompositiontemperature has shifted to 343.68°C. Therefore, the thermal destructive peak shifted to lower temperature (Figure 3).

In the case of for Ag nanoparticle + Co-Br-complex formulation, this thermogram shows one broaden endothermic peak at about 200°C corresponding to the melting point of silver nanoparticle, because the thermograms of complexes shows that these compounds are empty from melting point. The thermal decomposition temperature of this formulation is lower than that of pure complexes, by about 5°C. The exothermic decomposition temperature has shifted to 319.48°C.

CONCLUSION

By comparing thermal behaviour of four above mentioned ligands, we observed that their melting peak in the shape of sharp peak and the thermal destructive temperature of all synthesized compounds are also high. By considering the obtained thermograms from the mix of these compounds with silver nanoparticle, we understood the exothermic decomposition temperature shifted to lower temperature.

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