Thermal Properties of Manganese Chloride Salt Reinforced [PVA: PVP] Blend Films

Nuha A. Mohammed Saleh[1*], Dr. Sabah A. Salman[2]

Abstract

The casting process was used to make pure [PVA: PVP] polymer blend film and $MnCl_2.4H_2O$ salt augmented polymer blend film at varied weight ratios ((10, 20, 30, 40, 50) wt. percent). The influence of salt weight ratio on the thermal characteristics of [PVA: PVP] polymer blend films augmented with $MnCl_2.4H2O$ salt was also investigated. The coefficient of thermal conductivity of the [PVA: PVP] polymer blend films reinforced by $MnCl_2.4H_2O$ was found to be higher in the experimental results. As the weight ratio of $MnCl_2$. $4H_2O$ grows and then falls, the $MnCl_2.4H_2O$ salt increases and then reduces erratically. As the concentration of $MnCl_2.4H_2O$ salt rises, it is discovered that the thermal conductivity coefficient of whole polymer mix films is extremely low. As a result, such films could be utilized as heat-insulation shields. The temperature of glass transition and crystal melting temperature of [PVA: PVP] polymer blend films reinforced by $MnCl_2.4H_2O$ salt change as the weight ratio of $MnCl_2.4H_2O$ salt increases.

Key Words: PVA: PVP Polymer Blend, $MnCl_2.4H_2O$ Salt Reinforcement, Thermal Properties.

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Introduction

Polymers are becoming more popular as a result of their wide range of uses. Blending various polymers or inorganic components with polymers is a deliberate way to increase a material's performance, and it enables for the creation of innovative composite systems that outperform the parent mix. (Salman et al., 2016). Blending various polymers is one method employed to obtain novel materials with several characteristics, which primarily count upon the properties of the parent polymers and the configuration of the blend (Singh & Kulkarni, 2013). A semi crystalline polymer Polyvinyl alcohol (PVA), was investigated broadly because of its several remarkable physical characteristics, arising out of the presence of OH sets and the hydrogen connection establishment with other polymers or metals. Because of the peptide link, polyvinyl pyrrolidone (PVP) has planar and highly polar side groups. (Liu et al., 2014). Polymer blends are any two or more polymers combined as a consequence of a common production step. (Paul, 1978). Because of the existence of a stiff pyrrolidone group, which is particularly effective in drawing the group together, it is an amorphous polymer with a high (Tg). (Prakash et al., 2013). In this paper, we have discussed the preparation and categorization of [PVA: PVP] blend films, reinforced with various weight ratios of $MnCl_2.4H_2O$ Salt ((10, 20, 30, 40, 50) wt. %). The novel polymeric films thermal characterisation is critical for their development. (Alterovitz et al., 1989; Tuttle, 2012).

Corresponding author: Nuha A. Mohammed Saleh
Address: [1*]Department of Physics, College of Science, University of Diyala, Diyala, Iraq; [2]Department of Physics, College of Science, University of Diyala, Diyala, Iraq.
[1*]E-mail: nohaakk88@gmail.com
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Experimental Work

In the preparation of polymer blend films, polyvinyl alcohol powder (having a molecular weight of 13000-23000 g/mol, made by India's Central House (P) Ltd.), and polyvinyl pyrrolidone powder (produced by India's HIMEDIA Company with molecular weight 40000 g/mol), were used. For the reinforcement of the polymer blend, Manganese Chloride $MnCl_2.4H_2O$ With a molecular weight of 197.9 g/mol, salt is a product of the (company of CentralDrugHouse (P), Ltd. New Delhi-110002 (INDIA) was used. Pure [PVA: PVP] polymer blend film and $MnCl_2.4H_2O$ Using the casting process, salt reinforced polymer mix films were made in various weight ratios ((10, 20, 30, 40, 50) wt. percent). The powders of (PVA) and (PVP) with [1:1 wt. %], and $MnCl_2.4H_2O$ Salt powder with the above mentioned weight ratios were melted in distilled water by rousing for (1 h) at (60°C), and the solution is then poured into special glass molds placed on a plane surface and left until the solvent evaporates to obtain the [PVA: PVP] polymer blend films. The thickness measurement was (40-140) μm for thermal testing. For the purpose thermal measurement (Tg,Tm) for [PVA:PVP] polymer blend films with salt reinforce were conducted using a Differential Scanning Calorimeter (DSC), type STA PT1000, Linseys of origin (Linseys Company, Germany). The coefficient of thermo conductivity (k) was performed by employing the method of Lee's Disc for calculating the thermal conductivity of insulating materials using the device manufactured at the English company (Sabah et al., 2016).

Results and Discussion

Thermal Characteristics

Thermal Conductivity (k): Using Lee's Disc technique, the thermal conductivity coefficient (k) was determined. The coefficient of thermo conductivity of pure [PVA: PVP] polymer blend films and polymer blends films loaded with MnCl2.4H2O salt at various weight ratios is shown in Figure 1. ((10, 20, 30, 40, 50) wt.%). The coefficient of thermo conductivity of pure [PVA: PVP] polymer blend film is (0.0268 W/m. K) as shown in the figure, but once it is augmented with MnCl2.4H2O salt, the ratio of the thermal conductivity coefficient rises at the weight ratio. (10 wt.%) of $MnCl_2.4H_2O$ salt to reach (0.05373 W/m.K) and then starts to decrease irregularly to reach its lowest value of (0.02679 W/m.K) at the weight ratio (30 wt%) of $MnCl_2.4H_2O$ salt. The disorganized change of the rate of coefficient related to the thermal conductivity could be attributed to the in homogeneity amongst the principal material (polymer blend [PVA:PVP])and the reinforced material $MnCl_2.4H_2O$ salt due to the large surface area of $MnCl_2.4H_2O$ salt (Elashmawi et al., 2014). The difference in thermal conductivity values indicates that the thermal conductivity coefficient exhibits behavior independent of thermal capacity (Baraker & Lobo, 2016) Table (1) Indicates the values of Coefficient of thermal conductivity for all Polymer blends films.

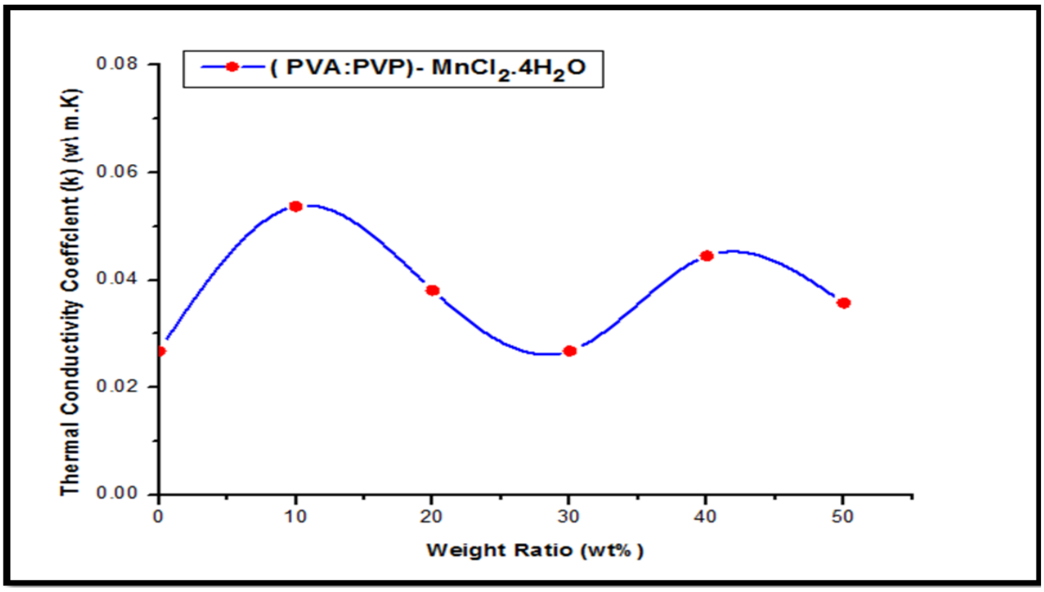

Figure 1. Thermal conductivity coefficient of (PVA: PVP)-$MnCl_2.4H_2O$ combined Films as a task of weight ratio of $MnCl_2.4H_2O$ Salt.

Table 1. Values of coefficient related to Thermal conductivity of pure [PVA: PVP] polymer blend films and with weight ratios of $MnCl_2.4H_2O$ salt

Weight Ratio (wt%) of Salt	k (W/m.K)
Pure [PVA:PVP]	0.0268
10	0.05373
20	0.03812
30	0.02679
40	0.0445
50	0.03575

Temperature of Glass-Transition

The temperature of glass transition (Tg) for pure [PVA: PVP] polymer blend film and polymer blends films packed with $MnCl_2.4H_2O$ salt at various weight rates ((10, 20, 30, 40, 50) wt%), was estimated by using Differential Scanning Colorimeter (DSC). Figures (2-7) show the glass transition temperature values films and DSC diagrams for all polymer blends films and it is mentioned in table (2). Also, it is observed that the temperature of glass transition of the pure [PVA: PVP] polymer blend film is (89.36°C), and after reinforcement with $MnCl_2.4H_2O$ salt we note that the glass transition temperature has decreased at the weight ratio (10 wt%) of $MnCl_2.4H_2O$ salt to reach (84.40°C) and then starts to rise irregularly to reach its highest value of (159.96 °C) at the weight ratio (50 wt.%) of $MnCl_2.4H_2O$ salt. The irregular change in the glass transition temperature is ascribed to the establishment of Nano-crystalline areas of different dimensions and appearance varying thickness in the crystalline domains, due to the reaction the salt crystals $MnCl_2.4H_2O$ salt with the base material ([PVA: PVP] polymer blend) (Zidan et al., 2016), As well as to a reduction in the movement of the chains of the [PVA: PVP] polymer blend reinforced by salt ($MnCl_2.4H_2O$ salt) (Baraker & Lobo, 2018).

Table 2. Temperature Glass transition values of pure [PVA:PVP] polymer blend film and with weight ratios of $MnCl_2.4H_2O$ salt.

Weight Ratio (wt%) of Salt	T_g (°C)
Pure [PVA:PVP]	89.36
10	84.40
20	87.53
30	87.27
40	129.31
50	159.96

Crystalline Melting Temperature

The temperature which is melting crystalline (Tm) for pure [PVA: PVP] polymer blend film and polymer blends films packed with $MnCl_2.4H_2O$ salt at various weight rates ((10, 20, 30, 40, 50) wt.%), was estimated by employing Colorimeter Differential Scanning (DSC). The nature and purity of a material are determined by its crystalline melting temperature. (Paul, 1978). The values of the crystalline melting temperature for all polymer blends films as shown in figures (2-7) and it is mentioned in table (3). (186.53°C) is the temperature melting crystalline of pure [PVA: PVP] polymer mix film and after reinforcement with $MnCl_2.4H_2O$ salt, the crystalline melting temperature increased irregularly to get at its maximum value of (252.22°C) at the weight ratio (30 wt.%) of $MnCl_2.4H_2O$ salt. except at weight rate (20 wt.%) of $MnCl_2.4H_2O$ salt, the crystalline melting temperature decreases compared to the crystalline melting temperature of the pure [PVA:PVP] polymer blend. The cause of the irregular increase in crystalline melting temperature is the formation of polymeric molecules interacting with each other, and this reaction will affect the temperature of melting crystalline of the pure [PVA:PVP] polymer blend due to salt reinforcement (Elashmawi et al., 2014). Moreover, to a decrease in bond strength between salt molecules, and smaller average size crystallites (Baraker & Lobo, 2018). We also note the appearance of an endothermic peak that is located after the crystalline melting temperature at the weight ratio (20wt%) representing the degree of dissolution (dissociation), which is symbolized by the symbol (T_d).

Table 3. Temperature of Crystalline melting values of pure [PVA: PVP] polymer Blend film and with weight ratios of $MnCl_2.4H_2O$ salt

Weight Ratio (wt%) of Salt	T_m (°C)
Pure [PVA:PVP]	186.53
10	196.61
20	180.09
30	252.22
40	228.78
50	219.85

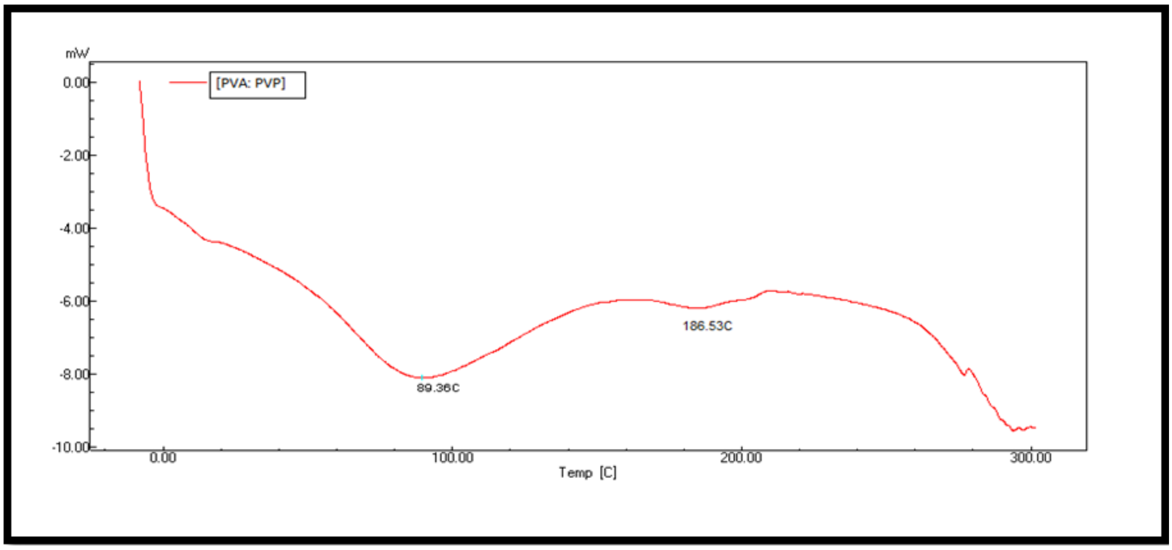

Figure 2. DSC Diagram of pure [PVA: PVP] blend film of polymer.

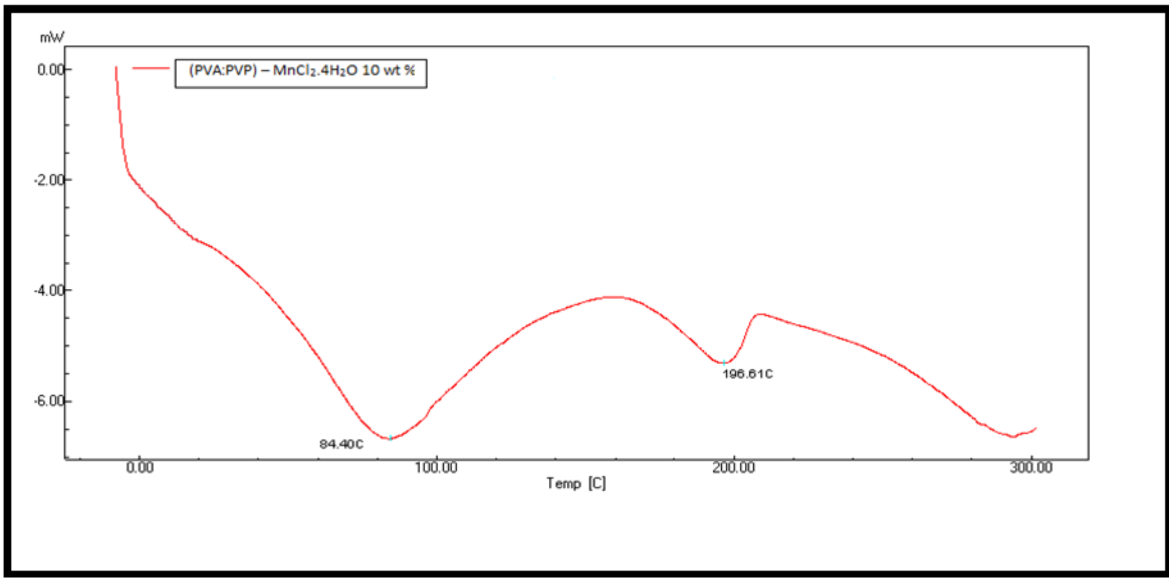

Fig. 3. [PVA: PVP] polymer blend film DSC reinforced by weight ratio (10 wt. %) of $MnCl_2.4H_2O$ Salt

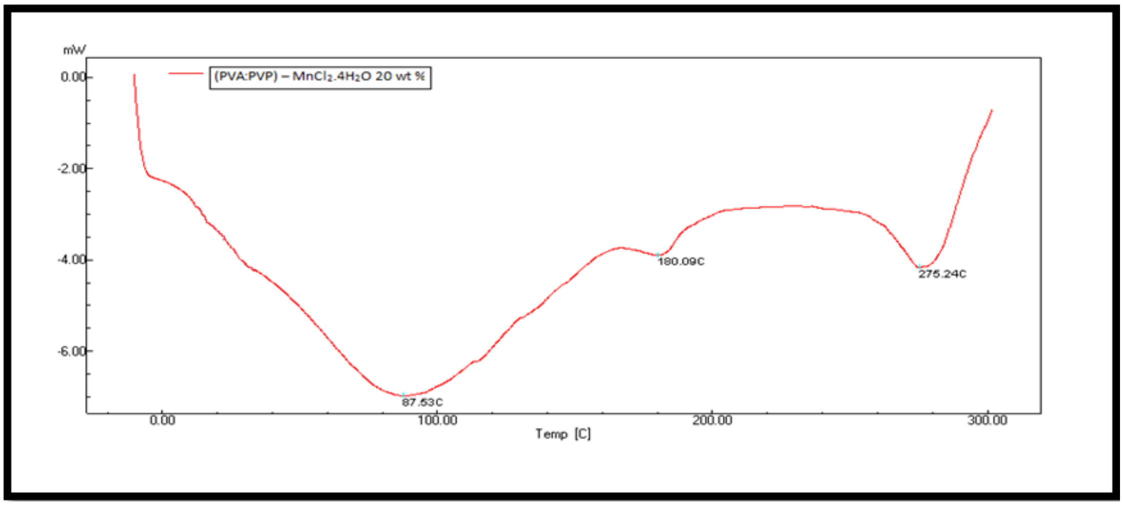

Figure 4. DSC Diagram of [PVA: PVP] polymer blend film reinforced by weight ratio (20 wt. %) of $MnCl_2.4H_2O$ Salt

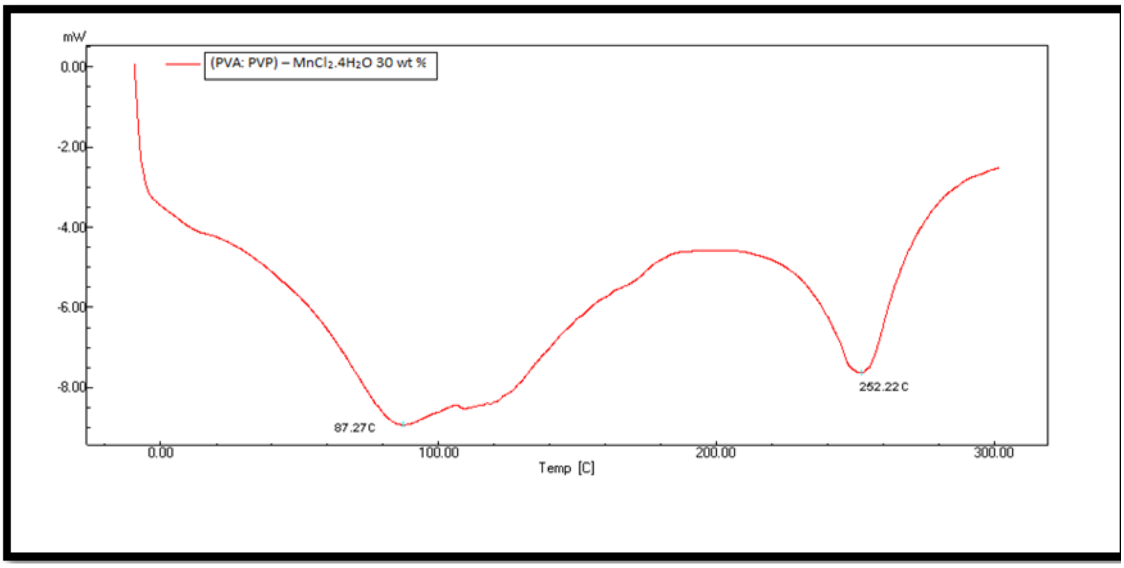

Figure 5. DSC Diagram of [PVA: PVP] polymer blend film reinforced by weight ratio (30 wt. %) of $MnCl_2.4H_2O$ Salt

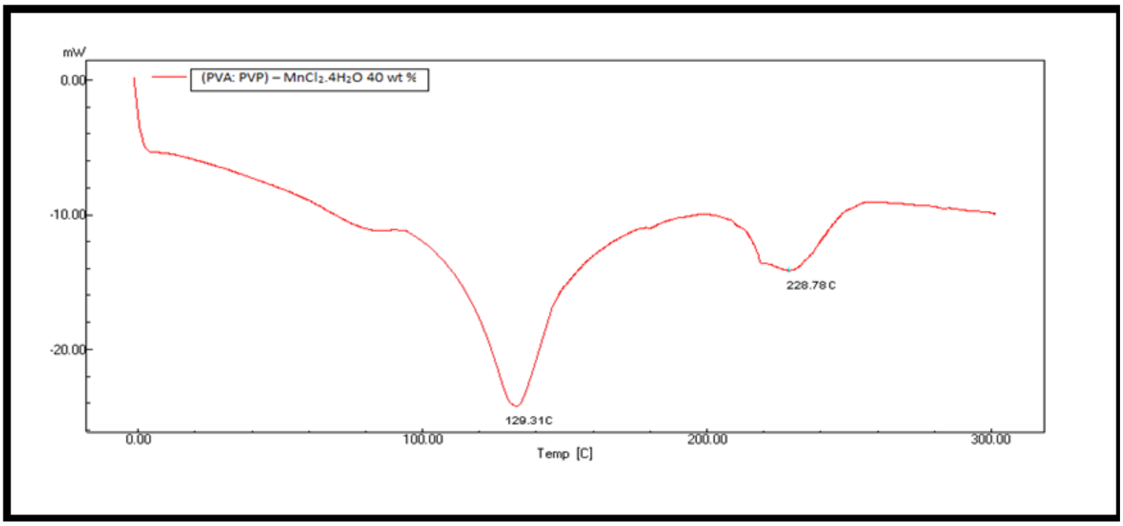

Figure 6. DSC Diagram of [PVA: PVP] polymer blend film reinforced by weight ratio (40 wt. %) of $MnCl_2.4H_2O$ Salt

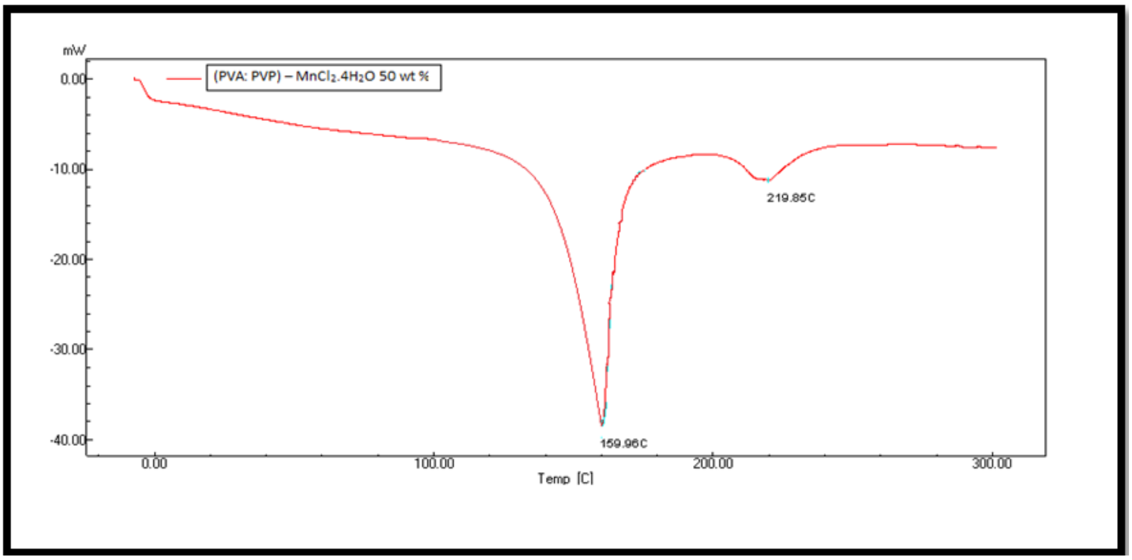

Figure 7. DSC Diagram of [PVA: PVP] polymer blend film reinforced by weight ratio (50 wt. %) of $MnCl_2.4H_2O$ Salt

Conclusions

The thermal conductivity coefficient of [PVA: PVP] polymer blend films reinforced with $MnCl_2.4H_2O$ salt increase then decrease irregularly with the increase of the weight rate of $MnCl_2.4H_2O$ salt. Small values of thermal conductivity coefficient suggest that all these polymer blends films could be employed as shields for insulating heat. The $MnCl_2.4H_2O$ reinforce the rate of temperature of glass transition and temperature of crystalline melting of [PVA: PVP] polymer blend films. $MnCl_2.4H_2O$ salt change with rising the weight ratio of $MnCl_2.4H_2O$ salt.

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