# PREPARATION AND STRUCTURE OF NANOCOMPOSITES BASED ON ZINC SULFIDE IN POLYVINYLCHLORIDE

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In this paper, presented the results of developing of new nanocomposite structures based on polyvinylchloride with cadmium and zinc sulfide and studied the distribution of nanoparticles CdS/ZnS by atomic force and scanning electron microscopies. Atomic force and electron microscopic study of samples of nanocomposites shows that the developed technology for producing nanocomposites allows to obtain a homogeneous and uniform distribution of Cd/Zn sulfide nanoparticles in a matrix of polyvinyl chloride. It is shown that with increasing concentrations of the starting solutions of reacting salts, the CdS/ZnS nanoparticle size increases in polyvinyl chloride matrix, i.e. in the formation of clusters CdS/Zn nanoparticles merge as a center of crystallization. Found that with increasing concentration of cadmium and zinc sulfide in the matrix increases the intensity of the photoluminescence spectra as compared with the spectra of the nanocomposite films with a low concentration of nanoparticles.

(Received November 18, 2017; Accepted January 4, 2018)

*Keywords*: nanocomposite, polyvinylchloride, photoluminescence, cadmium and zinc sulfide

## **1. Introduction**

Polymer blend is the most effective method to produce new properties in polymeric materials. This method is possible to make a potential of materials with good properties that is better than single segment polymers. Most important characteristics of the blend are easy for making and controlling of its properties [1].

Polyvinyl chloride (PVC) is one of the most important and generally utilized thermoplastic polymers currently in the world. Because PVC is the cheapest polymers to make and has a large range of properties therefore it can be used to make hundreds of products in the industry. The variety of PVC gives opportunity to use it from construction profiles to medical devices, from membranes to credit cards, from children's toys to pipes for water and gas.

Pure PVC is white and rigid. It has poor stability against heat and light. Using some additives or stabilizers the properties of PVC can be changed.

The effects of nanoscale calcium carbonate (nano-CaCO3) particles on the mechanical properties of different ductile polymer matrices were investigated by Ning Chen, Chaoying Wan, Yong Zhang, Yinxi Zhang. Polyvinyl chloride (PVC) was used as the matrix in the study [2]. The impact strength, flexural modulus and Vicat softening temperature of PVC blend was significantly enhanced after addition of 0–15 phr nano-CaCO3, but the tensile properties of the matrices showed different changes in the presence of nano-CaCO3. The ratio of yield strength and elongation at break of PVC were increased proportional by the addition of nano-CaCO3.

Hosseinloo and Sedaghat (2014) studied for enhancing the morphological and thermal properties of PVC using nanoclay (organoclay-OMMIT) [3]. In this study results showed that PVC/OMMIT nanocomposite polymers exhibited good thermal resistance than pure PVC. Also, X-ray diffraction analysis showed for the PVC/OMMIT nanocomposite polymers, the characteristic (001) diffraction peak decreased significantly in intensity and moved to lower angle.

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In accordance to above mentioned, it was interesting to synthesize the PVC with Zinc and Cadmium Sulfides. In this article described the research based on the different concentrations of each Sulfide on the PVC surface and study of their structure.

## 2. Materials and methods

#### 2.1. Materials

The polyvinyl chloride (PVC code CAS 9002-86-2) has a density 1.34 g/cm<sup>3</sup>, melting temp -150-220 ° C, molwt Mw - 40000-145000 by GPC, spark temp -  $625^{\circ}$  C, ignition temp -  $500^{\circ}$  C, auto-ignition temp ->1100 ° C.

ZnCl<sub>2</sub> has a density 2.907 g/cm3, melting temp - 290 °C, boiling point - 732 °C, solubility(in water) - 432.0 g/ 100 g (25 °C).

 $CdCl_2$  - has a density 3.327 g/cm3, melting temp - 568 °C, boiling point - 964 °C, solubility(in water) - 119.6 g/100 mL (25 °C).

Na<sub>2</sub>S - has a density 1.856 g/cm3, melting temp - 1,176 °C, solubility (in water) - 18.6 g/100 mL (20 °C).

#### 2.2. Research methods

Nanocomposite structure was studied by IR spectroscopy (spectrometer Varian 3600 FT-IR) at 4000-400 cm-1 and room temperature. The UV spectroscopy has been recorded on Spectrophotometer Specord 250 Plus. UV spectra were recorded at 200-700 nm and ambient temperature. Distribution of metal sulfide nanoparticles in the polymer matrix was studied by scanning electron microscopy (SEM, Jeol JSM-7600 F). Scanning was conducted in the SEI mode at an accelerating voltage of 15 kV and a working distance of 4.5 mm. X-ray diffraction (XRD) analysis was performed on Rigaku Mini Flex 600 XRD diffractometer at ambient. In all the cases, Cu K  $\alpha$ -radiation from a Cu X-ray tube (run at 15 mA and 30 kV) was used. The samples were scanned in the Bragg angle 2 h range of 20–70 °.

### **2.3. Sample preparation**

There have been prepared aqueous solutions 0.25 M, 0.01 M, 0.001 M of Zn/CdCl<sub>2</sub> and Na<sub>2</sub>S salts. Metal nanoparticles were added to the polymer solution at various ZnCl<sub>2</sub>/CdCl<sub>2</sub> volume contents (0.001M; 0.01M; 0.25M) and stirred for an hour to soak it. The mixture was transferred to a Petri dish through the filter paper and dried during the day. Nanocomposites have also been dried in a vacuum oven for 1 day to completely remove the solvent. Next day the metal doped PVC was stirred for soaking in the equivalent amount of Na<sub>2</sub>S solution and again was filtered from solution and dried for 1 day. By hot pressing at a melting temperature of PVC and 10 MPa pressure for 5 minutes and powders produced from these samples nanocomposites. Cooling the film after hot pressing was carried out in water and the cooling rate was 200 dg/min. Thus were synthesized nanocomposites with filler content CdS/ZnS - 0.25 M, 0.001 M, 0.01 M mass.%. The research on these films have been made on the devices above and the results of them are shown in the next chapter below.

### 3. Results and discussion

#### **3.1.** Luminescence

As we can see in Figure 1, after the addition of cadmium sulfide to the surface of polyvinyl chloride, the light-emitting properties of the polymer increased proportionally with increasing concentration. Intensity is specifically noticeable up to 400 nm, after that the indices go evenly down and at 630 nm they reduce the difference to zero.



*Fig. 1. Luminescence results on PVC + CdS (0.001; 0.01; 0.25)* (*PVC + 0.001M CdS, PVC + 0.01M CdS, PVC + 0.25M CdS*)

Compared with cadmium sulphide, the difference at the same concentrations for zinc sulfide in Figure 2 is almost identical, but on a sample with a concentration of 0.25, the reflective force was 675 nm which is an order of magnitude of higher than that of cadmium sulfide. At the same time, the decline occurred at around 700 nm. And the excitement began not with 350 but with 400 nm [4-5]



*Fig. 2. Luminescence results on PVC + ZnS (0.001; 0.01; 0.25) 1.PVC + 0.001M ZnS, 2.PVC + 0.01M ZnS, 3. PVC + 0.25M ZnS,4. Clean PVC* 

As we notice based on the graphs, saturation of polyvinyl chloride with metal sulphides had a positive effect on their light-absorbing properties.

#### 3.2. Infrared

From figure 3 to 7 show the IR spectra of pure PVC and nanocomposite based PVC[6]. There were found out that at different concentrations of special changes in the structure of the nanocomposite polymers.



Fig. 3. Pure PVC



*Fig.* 4. *PVC* + *ZnS* 0.001%



*Fig. 5. PVC* + *CdS* 0.001%





*Fig.* 7. *PVC* + *CdS* 0.25%

# 3.3. X-Ray diffraction

In this table we can see the difference between clean PVC(red line) and PVC with 0.001 CdS in it (blue line) Processing data obtained after X-ray tests we revealed that doping of polyvinyl chloride favorably affected their intensity. As can be seen in the figures 8 and 9, sulfides

increased the polymer intensity from 5,000 to 40,000 at a concentration of 0.25 m cadmium sulfide at 20 degrees. At the same degrees, the intensity of the polymer from zinc increased from 5.000 to 8.000 at a concentration of 0.25m.



Fig. 8. PVC + CdS X-rays



Fig. 9. PVC + ZnS X-rays

## **3.4. Scanning Electron Microscopy**

Figure 10 shows the image of a sample by scanning the surface with a focused beam of electrons. As we can see, the range after adding the 0.25 of CdS to PVC determined after testing as 134 nm-160nm.



Fig. 10. SEM image of PVC+0.25 of CdS

# 4. Conclusions

In this study, we developed the new nanocomposite structures, based on polyvinylchloride with cadmium and zinc nanoparticles and investigated its structure by IR, UV spectroscopy, scanning electron microscopy (SEM), X-ray diffraction analysis, IR studies showed that the introduction of nanosized fillers in the polymer matrix does not change its chemical structure, and changes the supramolecular structure of the polymer.

The SEM image shows that with increasing volume fraction of nano particles changes the supra molecular structure of the polymer and increase the size of the particles in the polymer.

#### References

- [1] I. S. Elashmawi, Naifa S. Alatawi, Nadia H. Elsayed, Results in Physics 2017, p 636.
- [2] Ning Chen, Chaoying Wan, Yong Zhang, Yinxi Zhang, Polymer Testing 23, 169 (2004).
- [3] Sadjad Sedaghat, Shahriar Ghammamy Synthesis of Polyvinyl Chloride /MMT Nanocomposites and Evaluation of their Morphological and Thermal Properties, Proceedings of the 5 th International Conference on Nanotechnology: Fundamentals and Applications Prague, Czech Republic, August 11-13, 2014
- [4] A. M. Magerramov, M. A. Ramazanov, A.X.Mustafayeva, K.Sh. Jabbarova, J. Nanotechnics, 2(26), 69 (2011).
- [5] A. M. Magerramov, M. A. Ramazanov, F. V. Gadzhiyeva, J.Appl.physics 3, 107 (2011).
- [6] Robert R. Stromberg, Sidney Straus, and Bernard G. Achhammer, Journal of Research of the National Bureau of Standards **60**(2), (1958).