

Project title and acronym (if any)	SYNTHESIS OF OPAQUE POLYMER PIGMENT AND ITS OPTICAL CHARACTERIZATION
Project web site (if any)	
Funding organization(s)	TÜBİTAK
Project no	110T768
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Budget	201.998,00 TL
Start-finish date	01/05/2011 – 01/05/2011
Project summary	<p>In the present work, a new generation opaque polymer pigment with multihollow structure was synthesized by suspension polymerization of “Water-in-Oil-in-Water” (W/O/W) emulsion system. Oil phase was methyl methacrylate and ethylene glycol dimethacrylate monomer mixture. The dimension and distribution of hollows inside polymer particles are dependent on the size of water droplets which are encapsulated in micelles. For Water-in-Oil (W/O) assembly, a hydrophobic surfactant and hydrophilic co-surfactant (Span 80-Tween 80) combination with a hydrophilic/lipophilic balance (HLB) value between 5-8 was used. The effects of surfactant and co-surfactant composition on the stability of the W/O emulsion and also on the size of water droplets were studied. In addition, the effect of the ultrasonication on the average size of water droplets was investigated.</p> <p>The hollow size distribution which may possibly give the maximum scattering efficiency was predicted by a mathematical model based on the Mie scattering. The optimum size distribution for W/O emulsion was obtained at the monomer/surfactant/water ratio of 75.5/9.4/15.1 after ultrasonication for 30 seconds at 80 W power.</p> <p>The W/O/W emulsion was prepared by dispersing the W/O emulsion in aqueous solution of hydrophilic Triton X-405. The influence of surfactant concentration and mechanical mixing on monomer droplets was investigated by size measurement and optical microscopy. After stabilizing with 1% (w/w) polyvinylpyrrolidone (PVP) solution, the W/O/W emulsion was polymerized at 55°C for 20h. The surface morphology of synthesized polymer pigments was analyzed by scanning electron microscopy (SEM) and the inner hollow structure was confirmed by transmission electron microscopy (TEM). The analysis indicated that multihollow opaque polymer pigments were successfully synthesized.</p>

The opacity, the $L^*a^*b^*$ color, and the gloss properties of polymer pigments were examined by spectrophotometer and glossmeter. The opacity values were assessed by contrast ratio measurements, and the synthesized polymer pigments provided up to 97.3 % opacity (50% (v/v) solid content). In addition, the pigments exhibited low gloss values, and yielded matt films.

Scientific, technological, economic and social gains obtained or expected by the project

Pigments are used as colorants and fillers in many materials such as paints, cosmetics, and polymers. Most of the white pigments and extenders used in paint industry are inorganic substances like calcite, titanium dioxide, zinc sulfide, zinc oxide, and baryte. The incompatibility between inorganic pigments and organic resins causes severe paint defects and may result in phase separation, agglomeration, or settling. The high density difference between organic vehicle and inorganic pigments is another source of such defects.

In the last decade, the hollow polymer particles have received significant attention with their lower density and high compatibility with organic paint resins, and so have become better options as opaque polymer pigments to traditional white pigments. Opaque polymer pigments have a structure with thin polymeric shell and a single void inside (Figure 1a).

The increase in the number of hollows inside polymer particles enhanced the scattering efficiency and imparted higher opacity and hiding power than single-hollow particles. The illustration for the developed structure is given in Figure 1b.

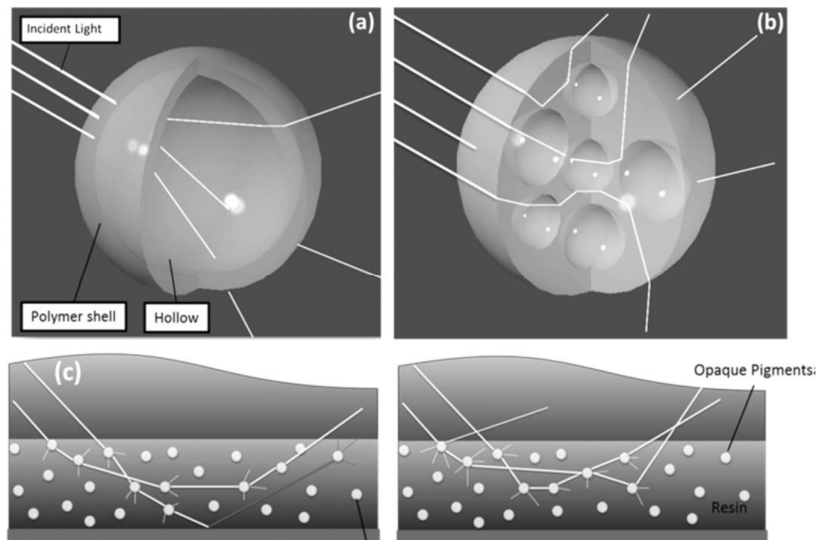


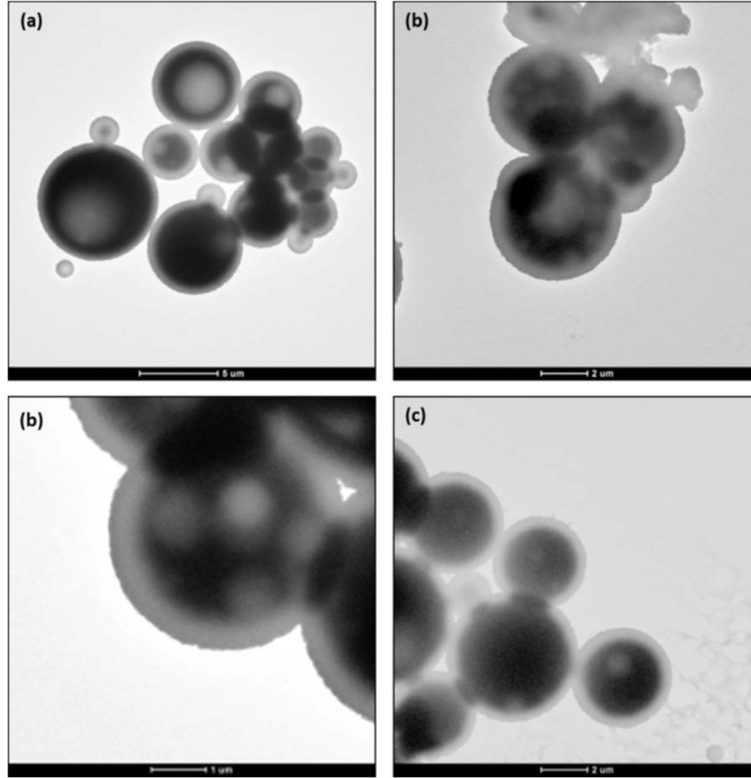
Figure 1. Illustration of (a) single-hollow, (b) multihollow polymer pigment, and (c) the mechanism of the improvement of hiding efficiency.

Publications derived from the project

Asmaoğlu S., Gündüz G., Maviş B. ve Çolak Ü., "Synthesis of Opaque Polymer Pigment and Its Optical Characterization," Proceedings of the First International Conference on Materials, Energy and Environments - ICMEE 2012, 1-3 (2012).

Asmaođlu S., Gündüz G., Maviş B. ve Çolak Ü., "Synthesis and characterization of multi-hollow opaque polymer pigments," Journal of Applied Polymer Science, accepted, DOI: 10.1002/app.43696.

Figures and images related to the project



Şekil 2. TEM micrographs of multihollow polymer pigments synthesized under different conditions.