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A facile and efficient method to investigate the effect of the nature of surfactant and continuous phase on the performance of emulsion explosive

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ABSTRACT

An investigation was performed into the performance of emulsion explosive via studying on the storage modulus of its matrix. The experimental results show that there is a tight relationship between storage modulus and the performance of emulsion explosive because both have strong connection with droplet size. A higher G′ represents a superior performance of emulsion explosive. The storage modulus was taken to investigate the effect of the nature of surfactant and continuous phase on the performance of emulsion explosive. It was found that the stronger interaction between surfactant and dispersed phase improve the performance of emulsion explosive. But, the increase of polarity of continuous phase decreased the performance of emulsion explosive.

1. Introduction

Emulsion explosive is one of the important industrial explosive of the world. It is developed from early 1980's and widely accepted by customers for the advantages of water-proof, non-TNT, high safety and good explosion performance [1]. The emulsion explosive matrix (EEM) is a typical highly concentrated water-in-oil emulsion, and the dispersed phase droplets are ranged in a polyhedral closely packed configuration that is far beyond the close packing limit of spherical droplets [2,3]. The dispersed phase droplets consist of a supersaturated aqueous solution of inorganic oxidizer salts, which are primarily but not limited to, ammonium nitrate [4,5].

The performance of EEM is the major focus of researchers' interest [6]. However, it is always absence a simple and accurate method to estimate the performance. A traditional method is via testing the droplet size of EEM to predict the performance of emulsion explosive. Generally, the small droplet size improves the performance. However, due to the polydispersity of EEM, it is difficult to gain the droplet size accurately. Another common method is measuring the VOD of emulsion explosive. Though this method provides the performance directly, it is unsafe and complicated.

Recently, the rheological properties of emulsion explosive matrix have been the subject of many studies. The rheological behavior specific for EEM, and which is due to its microstructure, has attracted a lot of attention. I. Masalova found that the rheological behavior of an emulsion matrix could be changed, that its Newton's flow region could be reduced, that apparent viscosity could increase and show yield characteristics during the shelf life [7–11]. R. Pal proposed a model for predicting the linear viscoelastic behavior of emulsions [12,13]. Princen and Kiss showed that the rheological properties are characterized by elasticity at low shear stresses and the existence of yielding behavior [14–16]. In our previous work, systematical studies were proposed on the rheology of emulsion explosive matrix and the effect of surfactants on the rheology of matrix [17–19]. These researches show that the rheological property is associated with the structure of EEM, especially the droplet size of dispersed phase. Due to the tight relationship between rheological properties and structure of EEM, we can speculate that there are some relations between the rheological properties and the performance because the performance is mostly decided by the structure of EEM. The variation of rheological properties may represent the change of

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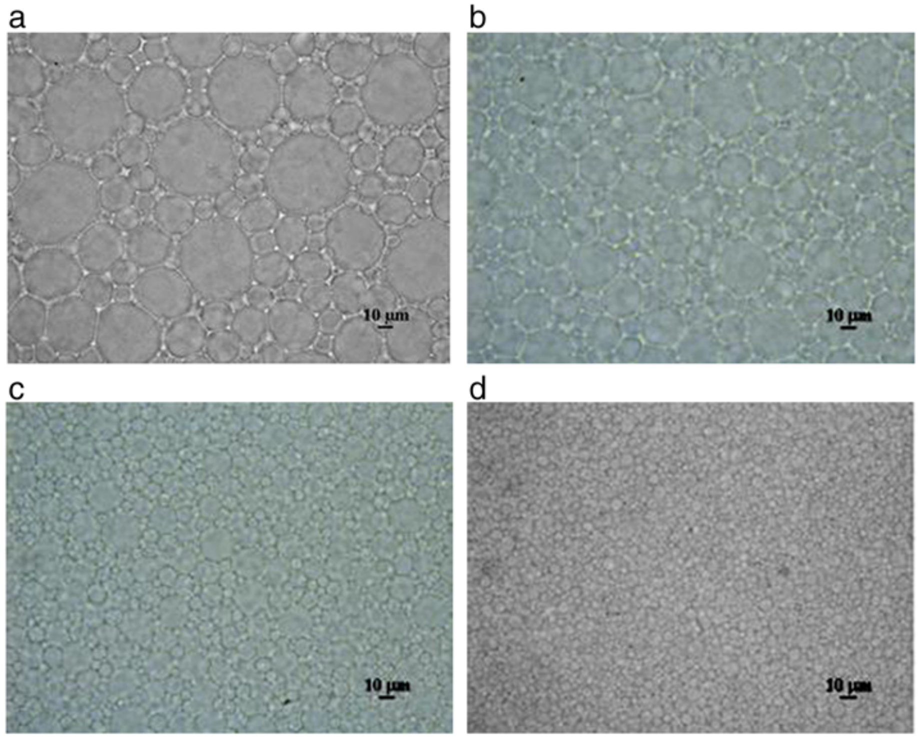

Fig. 1. Microstructure images of EEM formed at different rotational speed (a) formed at 425 r/min (b) formed at 705 r/min (c) formed at 985 r/min (d) formed at 1410 r/min.

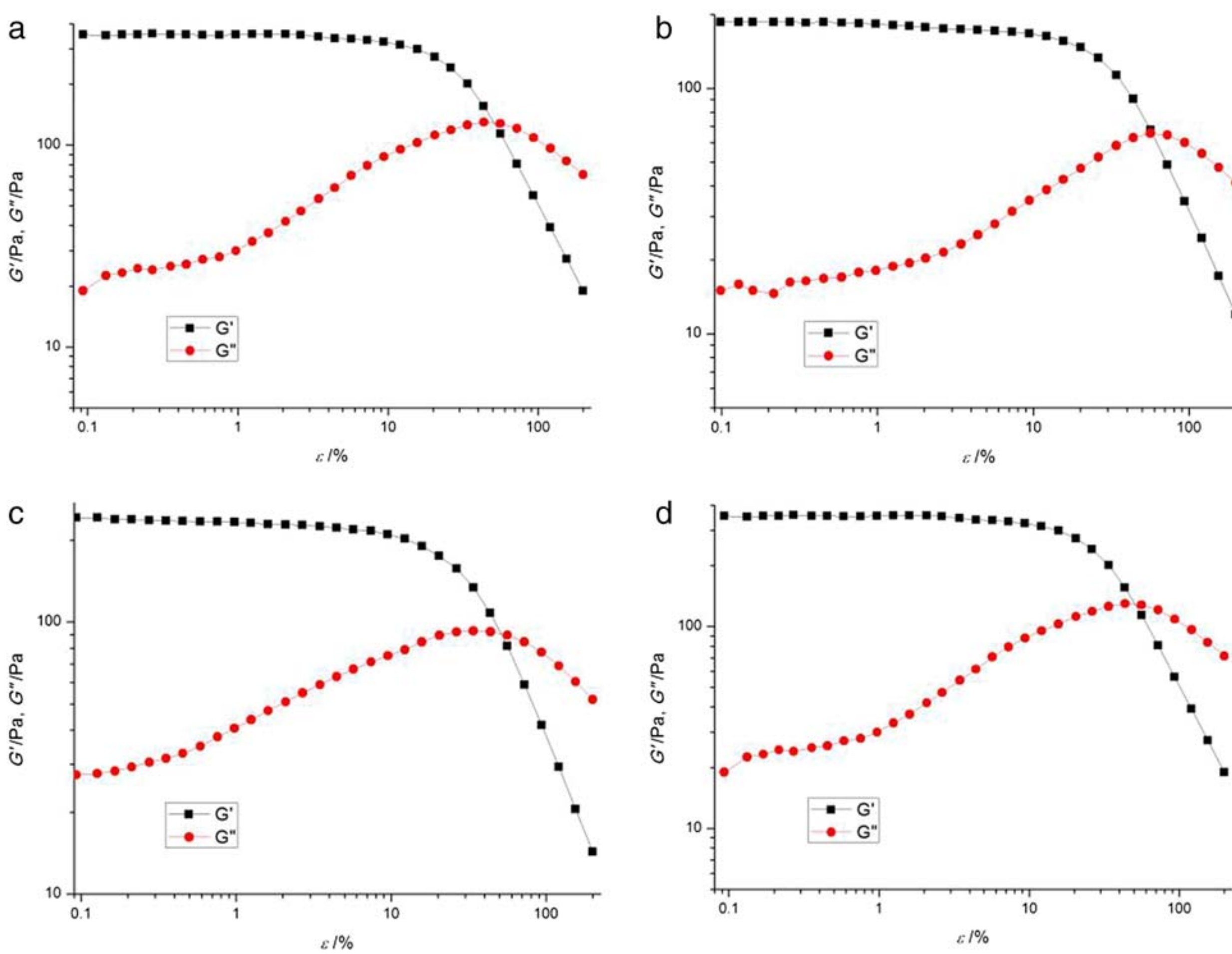

Fig. 2. The effect of rotational speed on the visco-elasticity of EEM (a) formed at 425 r/min. The A region is the LVER; The B region is the non-liner visco-elasticity region; The C region is the viscosity region (b) formed at 705 r/min (c) formed at 985 r/min (d) formed at 1410 r/min.