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Enhancement Mechanical Properties of Barium Chloride by Adding Copper Chloride using Ultrasonic Technique

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Abstract:
Some of physical properties of BaCl2 dissolves in distilled water had been studied at different concentrations (0.05%, 0.1%, 0.15%, 0.2%, 0.25% and 0.3%) (gm./ml) before and after adding (0.3)gm of CuCl2 for all concentrations , the mechanical properties such as ultrasonic velocity had been measured by ultrasonic waves system at frequency 25 KHz, other mechanical properties had been calculated such as absorption coefficient of ultrasonic waves, relaxation time, relaxation amplitude, specific acoustic impedance, compressibility and bulk modules. The results show that all these properties are increasing with the increase of the polymer concentration except compressibility is decreasing with the increase of the concentration; results show that when adding CuCl2 these properties are increasing except compressibility is decreasing. Results also shows that adding CuCl2 to BaCl2 enhances the ultrasonic absorption coefficient as a result of high values after addition.
Keywords: BaCl2 solution, CuCl2 solution, mechanical properties, ultrasound technique.

1. Introduction

TheBaCl2 is a water-soluble synthetic polymer, due to the characteristics of easy preparation, good biodegradability, excellent chemical resistance, and good mechanical properties, BaCl2 is used mainly as a solution in water but its solubility in water depends on temperature, [1]. BaCl2 is available as colorless crystals and salt barium is the most important and has high degradation in water .An improved understanding of the excited state structure and dynamics in conjugated polymers should aid in the design of more efficient materials for such applications. The prevailing view is that these materials can be thought of as collections of chain segments with varying conjugation lengths, whose proximity to each other does not affect their fundamental electronic structure, but whose intramolecular excision states interact via weak, Forster-type interactions [2] Copper(II) chloride is the chemical compound with the formula $CuCl_2$. This is a light brown solid, which slowly absorbs moisture to form a blue-green dihydrate. The copper(II) chlorides are some of the most common copper(II) compounds, after copper sulfate. Anhydrous $CuCl_2$ adopts a distorted cadmium iodide structure. In this motif, the copper centers are octahedral. Most copper(II) compounds exhibit distortions from idealized octahedral geometry due to the Jahn-Teller effect, which in this case describes the localization of one d-electron into a molecular orbital that is strongly antibonding with respect to a pair of chloride ligands. In $CuCl_2 \cdot 2H_2O$, the copper again adopts a highly distorted octahedral geometry, the Cu(II) centers being surrounded by two water ligands and four chloride ligands, which bridge asymmetrically to other Cu centers solvent effects might therefore be expected to influence the ultrasonic relation behavior, the absorption of ultrasonic in liquid systems is governed by local modes of motion and cooperative whole molecule movement because of the strong intermolecular interaction it should be possible to observe cooperative motion in the ultrasonic range.. However these properties are dependent on humidity, in other words, with higher humidity more water is absorbed, the water which acts as a plasticizer, will then reduce its tensile strength, but increase its elongation and tear strength. Acoustic relaxation measurements on other solutions have been reported by several workers[8,9], ultrasonic technique is good method for studying the structural changes associated with the information of mixture assist in the study of molecular interaction between two species; some of mechanical properties of different solutions were carried by some workers using ultrasonic technique[10]. The purpose of this research was to investigate the physical properties of BaCl2 with CuCl2 as aqueous solutions by ultrasound wave at fixed frequency (25 KHZ) and study the effect of adding CuCl2 on the physical properties of BaCl2 to enhance its different applications.

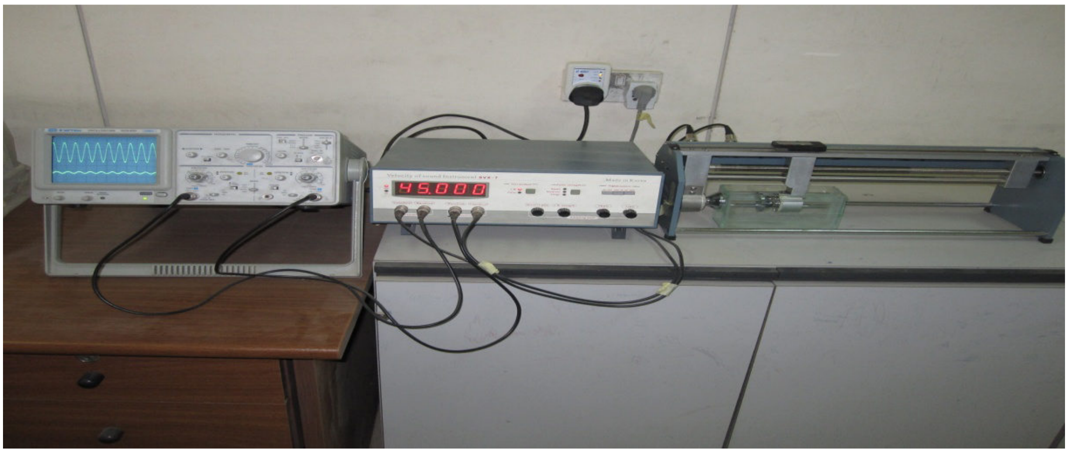
2. Experimental:

2.1 Preparation of Solutions:

BaCl2 (Gerhard Buchman –Germany) with assay (99%) and CuCl2 (Messina) with assay (99.8%) [11] .The BaCl2 solutions were prepared by dissolving a known weights of BaCl2 powder in a fixed volume (400 ml) of distilled water under stirring at 70oC for (30 min). The BaCl2 concentrations were (0.05%, 0.1%, 0.15 %, 0.2%, 0.25% and 0.3%) gm./ ml ; then CuCl2 was added with weight (0.3 gm.) to all BaCl2 Concentrations. The resulting solution was stirred continuously for (30 min) until the solution mixture became a homogeneous.

2.2 Ultrasonic measurements:

Ultrasonic measurements were made by pulse technique of sender-receiver type (SV-DH-7A/SVX-7 velocity of sound instrument) with constant frequency (25 KHz),as shown in Fig. below the receiver quartz crystal mounted on a digital venire scale of slow motion, the receiver crystal could be displaced parallel to the sender and the samples were put between sender and receiver. The sender and receiver pulses (waves) were displaced as two traces of cathode ray oscilloscope, and the digital delay time (t) of receiver pulses were recorded with respect to the thickness of the samples (x). The pulses height on oscilloscope (CH1) represents incident ultrasonic wave's amplitude (A0) and the pulses height on oscilloscope (CH2) represents the receiver ultrasonic wave's amplitude (A).



The instruments of ultrasonic system

2.3 Theoretical calculations:

The absorption coefficient (α) was calculated from Lambert – Beer law[12]:

$$A/A_0 = e^{(-\alpha x)} \cdots\cdots\cdots(1)$$

Where (A_0) is the initially amplitude of the ultrasonic waves,(A) is the wave amplitude after absorption and (x) is the thickness of the sample.

The ultrasonic wave velocity (V) was calculated using the following equation[13]:

$$V = x/t \cdots\cdots\cdots(2)$$

Where (t) is time that the waves need to cross the samples (digital obtained from the instrument). Attenuation is generally proportional to the square of sound frequency so the relaxation amplitude (D) was calculated from the following equation[14] where (f) is the ultrasonic frequency:

$$D = \frac{\alpha}{f^2} \cdots\cdots\cdots(3)$$

The acoustic impedance of a medium (Z), it was calculated by equation[15]:

$$Z = \rho V \cdots\cdots\cdots(4)$$

Bulk modulus (K) is the substance's resistance to uniform compression, it is defined as the pressure increase needed to decrease the volume; it was calculated by Laplace equation[16] :

$$K = \rho V^2 \cdots\cdots\cdots(5)$$

Compressibility (B) is a measure of the relative volume change of a fluid or solid as a response to a pressure (or mean stress) change, it was calculated by the following equation[17]:

$$B = (\rho V^2)^{-1} \cdots\cdots\cdots(6)$$

The relaxation time (τ) was calculated from the equation[18]:

$$\tau = 4\eta_S / 3\rho V^2 \cdots\cdots\cdots(7)$$

3. Results and Discussion:

(Fig.2) shows that absorption coefficient is increasing with concentration this attributed to the fact that when polymer concentration increase there will be more molecules in solution this lead to more attenuation against wave propagation, the attenuation can be attributed to the friction and heat exchange between the particles and the surrounding medium as well as to the decay of the acoustic wave in the forward direction due to scattering by the Particles [15], this behavior same to that give by [19] for other polymers, adding CuCl2 enhances absorption coefficient by increasing its values. This attributed that there were more flexibility for these polymer chains in solution as a result of adding CuCl2 molecules, and because ultrasonic waves propagate as compression and rarefaction in a medium so there are variation in density medium and there were more attenuation to energy of ultrasound waves when adding CuCl2[20]. Ultrasonic velocity is increasing with increasing CuCl2 as shown in (Fig.1) this because structural or volume relaxation it occurs in associated liquids such as polymers, a liquid when at rest has a lattice structure similar to that possessed by solid when waves are propagated through it, the resultant periodic changes of wave pressure causes molecules to flow into vacancies in the lattice during compression phase and to return to their original positions in the lattice during rarefaction so when adding CuCl2 the vacancies were accupied by these molecules lead to increases the velocity [21].. The compressibility is decreasing with the increase of concentration (Fig.3) and attributed to the fact that in Laplace equation no. (6) There are inverse proportionality between compressibility and ultrasonic velocity [23, 24]. Ultrasonic relaxation time was calculated by using equation no. (7) Shown in (Fig.4) and the relaxation amplitude shown in (Fig.5) calculated from equation no.(3) their values are increasing with concentration, this behavior same to that give by [19] for other polymers, also (Fig.4) Shows that relaxation time decreased when adding CuCl2 this attributed to the fact that ultrasonic energy depends on viscosity thermal conductivity, scattering and intermolecular processes , thermal conductivity and scattering effects are known to be negligible and since CuCl2 increase velocity so relaxation time must decrease [18] Specific acoustic impedance shown in (Fig.6) is increasing with concentrations this behavior same to that given by [25] for other polymers and attributed to the equation no. (4) has only one variable parameter which is velocity and density has very small variations with respect to that of velocity. And the bulk modulus is increasing with concentration (Fig.7) ; this behavior same to that give by [26].(Fig.6) shows that adding CuCl2 increased acoustic impedance because CuCl2 chains fills the valances by swallowing water molecules and be closer to BaCl2 macromolecules that increasing Specific acoustic impedance[27].

4. Conclusion

1. Adding CuCl2 polymer to BaCl2 enhances the ultrasonic absorption coefficient as a result of high values after addition so it can be used as coated materials for moving bodies in order to detect its by ultrasonic technique .
2.Adding CuCl2 increases the ultrasonic velocity so it can be used as good medium for transforming ultrasonic waves in such medical instruments.
3. Adding CuCl2 reduced compressibility this lead to increase interaction between polymer molecules this cause enhancement for mechanical properties against environments .

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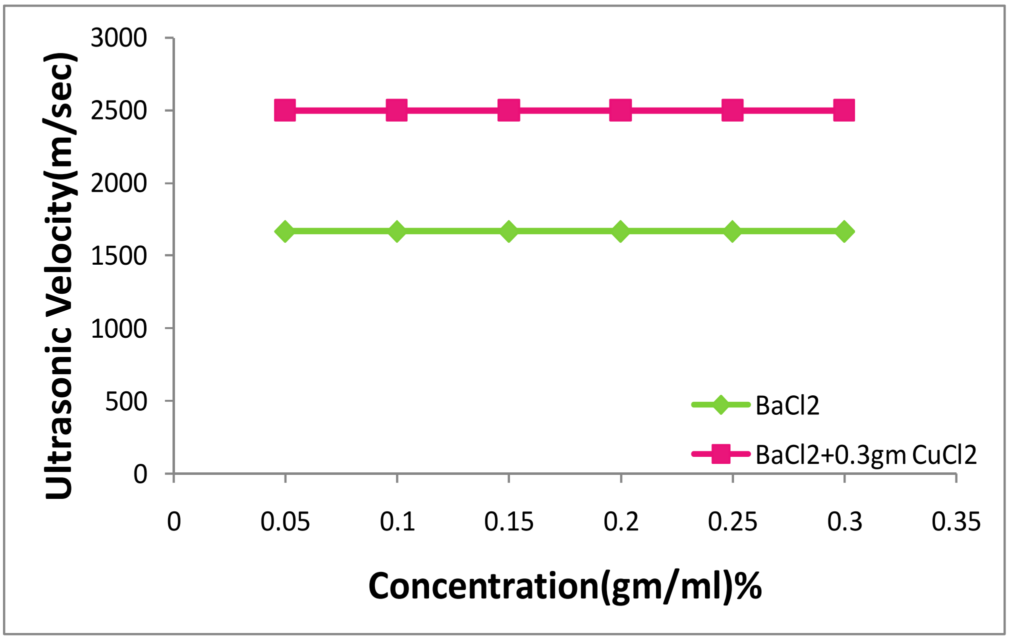

Fig.1. Ultrasonic Velocity due to concentration

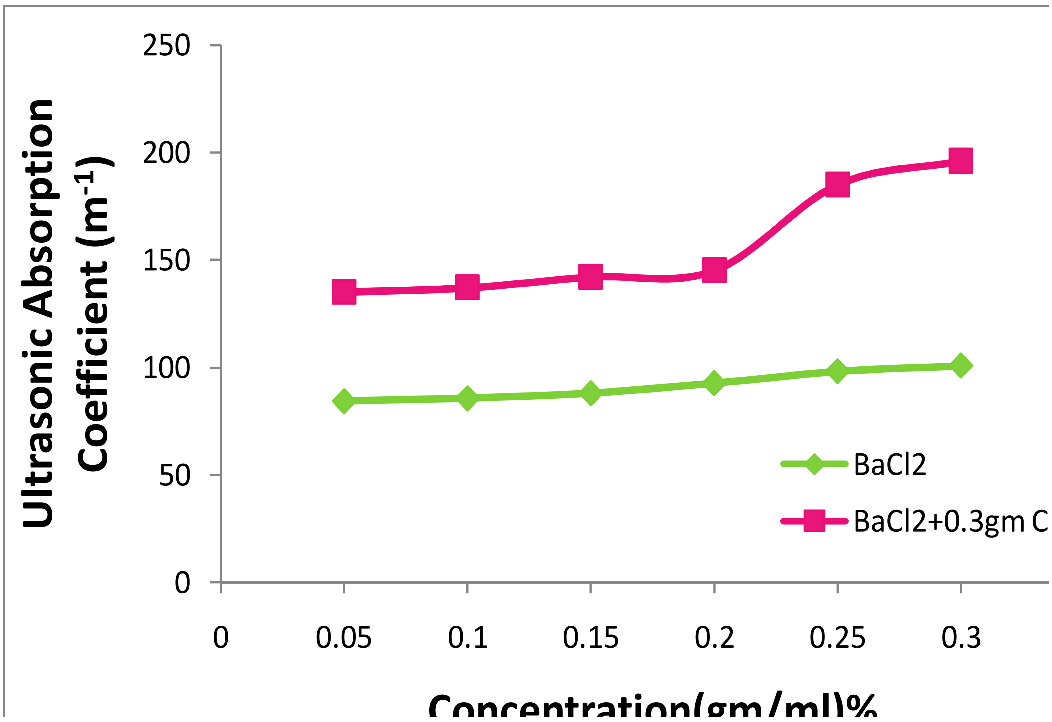

Fig.2. Absorption coefficient due to concentration

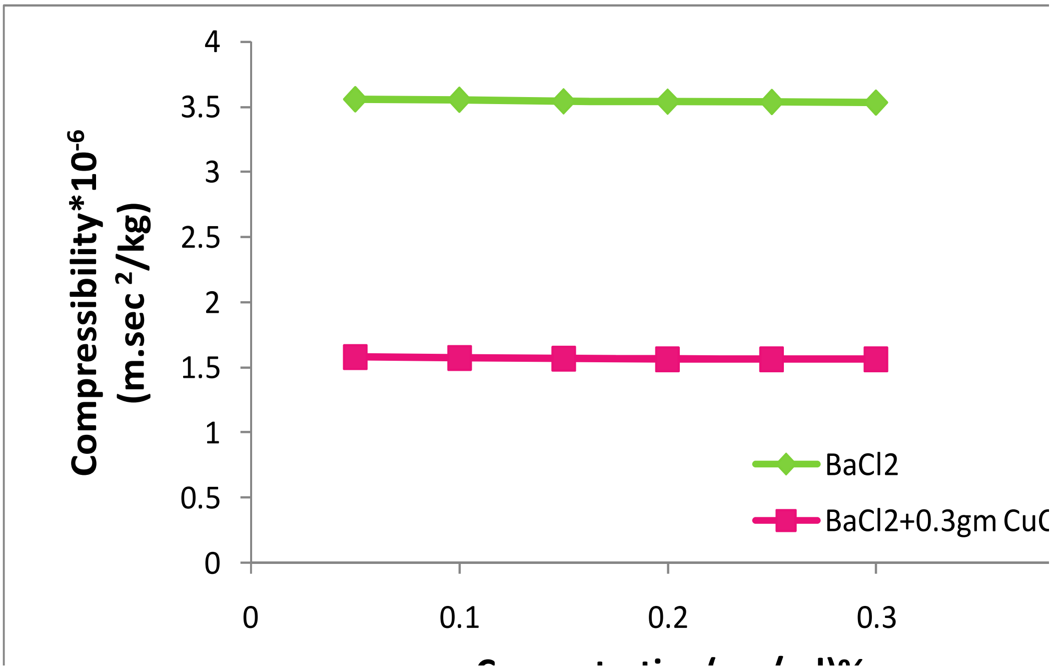

Fig.3. Compressibility due to concentration

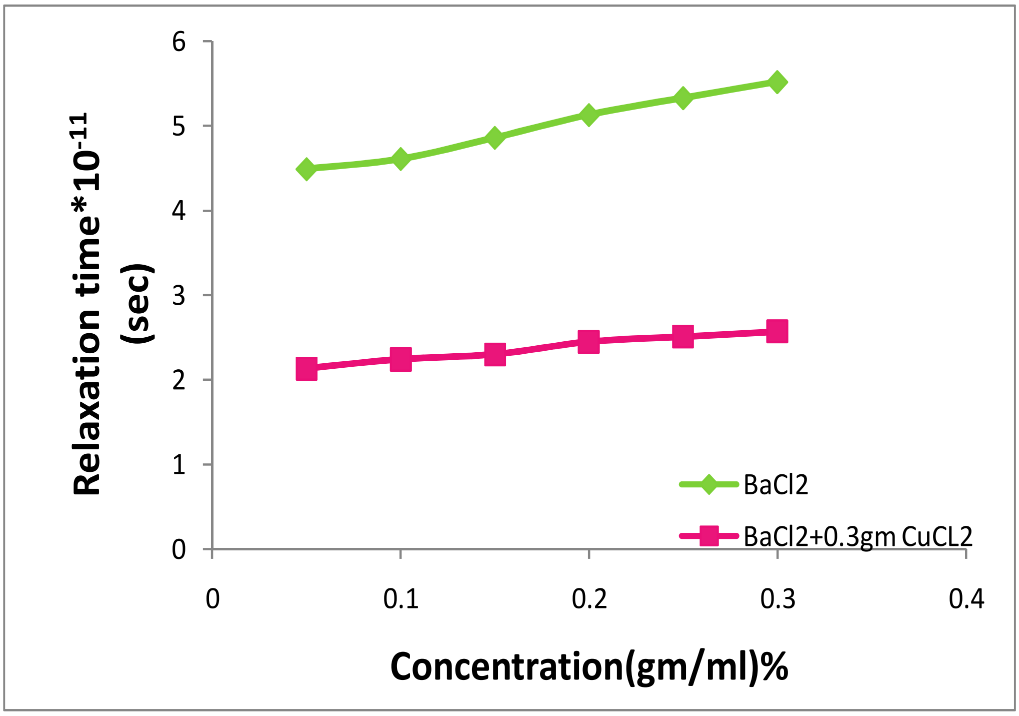

Fig.4. Relaxation time due to concentration

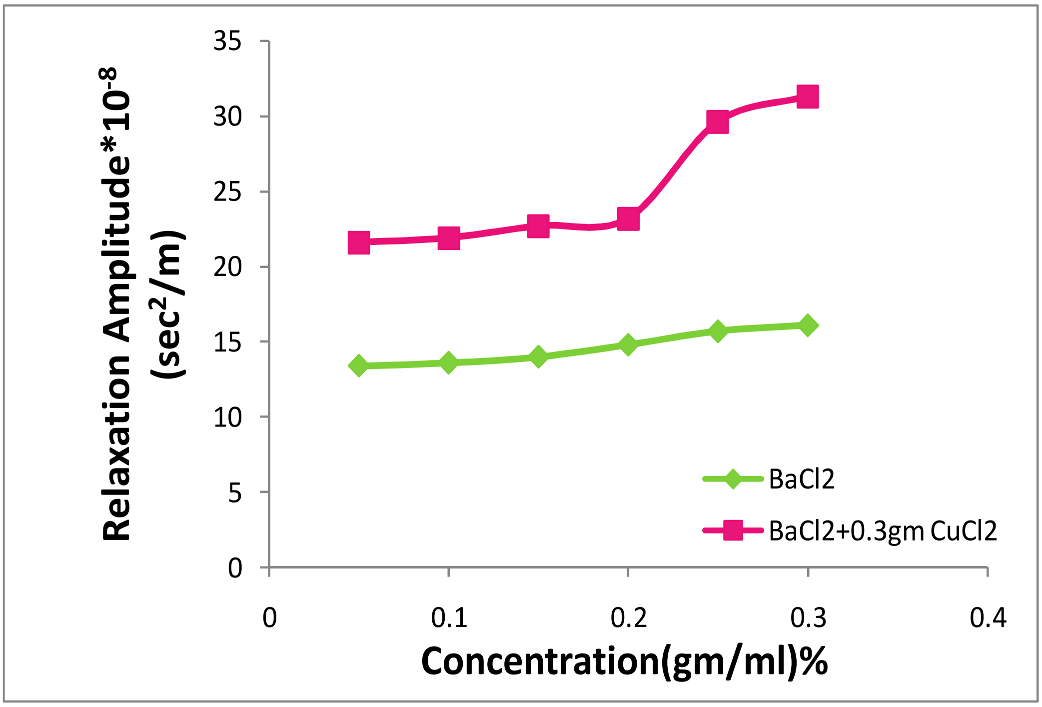

Fig.5. Relaxation amplitude due to concentration

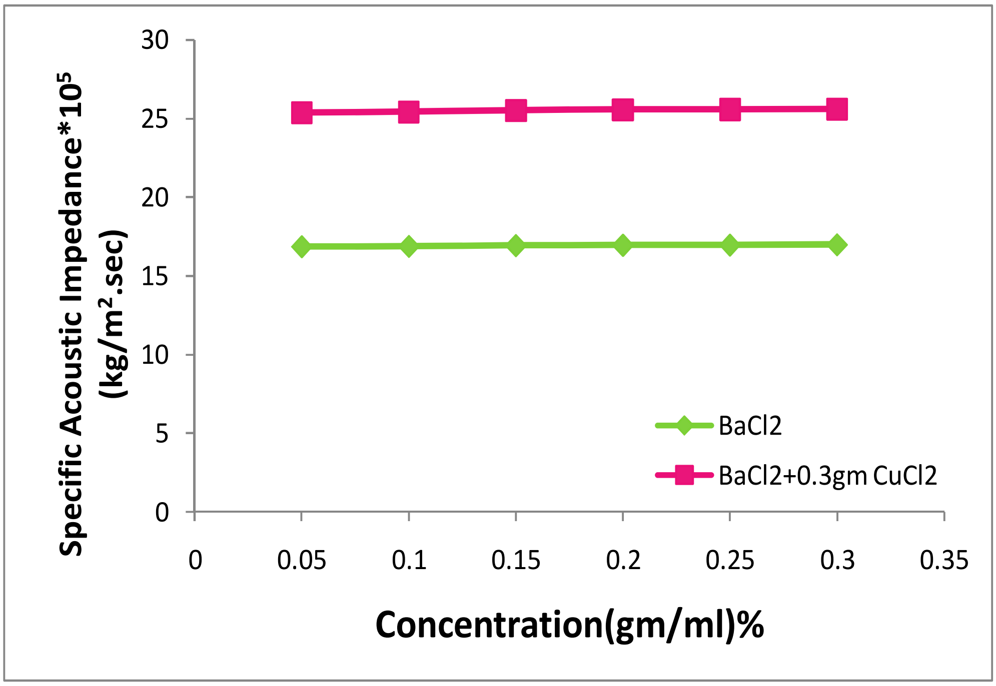

Fig. 6.Acoustic impedance due to concentration

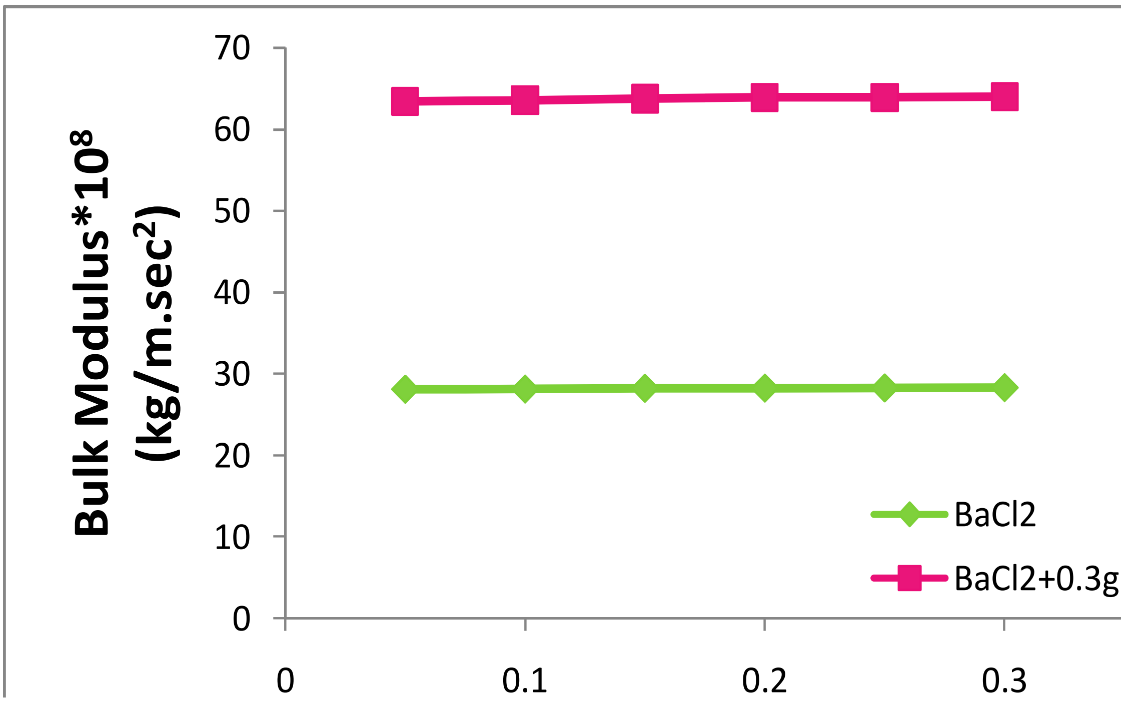

Fig.7. Bulk Modulus due to concentration