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## Studies on infrared spectra for cupric ion bound Guargum-graft-acrylamide

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### Abstract

$Y_1Ba_2Cu_3O_{7-x}$  superconductor can be prepared by polymeric precursor technique. Guargum-graft-acrylamide (G-g-Am) was selected as polymeric part. Initial step is to understand nature of ion binding by G-g-Am at higher pH. In this present investigation groups involved from G-g-Am in binding  $Cu^{2+}$  have been understood. IR spectral study indicates  $-COO^-$  groups and  $-OH$  groups from G-g-Am may have role in ion binding at higher pH.

**Keywords:** Graftcopolymer, cupric ion, ion binding, infrared spectra, bidentate chelating, ceramic oxide.

### 1. Introduction

Guargum is a water soluble natural polymer [1]. So it is economically suitable. Its structure is shown in fig.1. But aqueous solution of guargum has poor biodegradation resistance [2]. If polyacrylamide side chains are grafted on guargum backbone, resulting graft copolymer will contain backbone and side chains. Guargum-graft-acrylamide (G-g-Am) has been found to be considerably biodegradation resistant and efficient flocculent for metallic ions [2]. So G-g-Am may be a choice as a polymer to produce  $Y_1Ba_2Cu_3O_{7-x}$  ceramic oxide superconducting material by polymeric precursor technique. In this present investigation, groups from G-g-Am involving in binding  $Cu^{2+}$  ions at higher pH have been understood using infrared (IR) spectral study.  $-COO^-$  groups from side chains and  $-OH$  groups from backbone may have role in ion binding.

### 2. Materials and Methods

#### 2.1 Guargum-graft-acrylamide (G-g-Am)

Guargum-graft-acrylamide used in this present investigation has been achieved from Rheological Laboratory of Materials Science Centre of I.I.T., Kharagpur. For grafting polyacrylamide side chains on guargum, ceric ion initiation method has been adopted [2]. From ESCA study, it was possible to understand that it contains approximately 11 atom% nitrogen, 22 atom% oxygen and 68 atom% carbon [3].

#### 2.2 Cupric ion bound G-g-Am (G-g-Am- $Cu^{2+}$ )

Aqueous solution of G-g-Am when is mixed with cupric nitrate solution and pH is raised by adding ammonia solution, a mass separates which is washed with water for some time and then with methanol for some time and then it is kept in the oven for drying for IR spectral study.

#### 2.3 G-g-Am- $Na^+$

Aqueous solution of G-g-Am is mixed with sodium hydroxide solution and the mixture is immediately poured into methanol for precipitation. Precipitate is washed with water for some time. Then it is kept in the oven for drying for IR spectral study.

#### 2.4 Cupric nitrate solution

$Cu(NO_3)_2$  solution has been prepared by dissolving cupric oxide in nitric acid.

#### 2.5 IR spectra

IR spectra for G-g-Am- $Na^+$  and G-g-Am- $Cu^{2+}$  have been registered between  $4000\text{ cm}^{-1} - 200\text{ cm}^{-1}$  with a Perkin-Elmer model 883 spectrometer using potassium bromide pallets.

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### 3. Results and Discussion

IR spectra for G-g-Am-Na<sup>+</sup> and for G-g-Am-Cu<sup>2+</sup> are shown in fig.2 and fig.3 respectively. Peak at 3423 cm<sup>-1</sup> in the IR spectra for G-g-Am-Na<sup>+</sup> and peak at 3418 cm<sup>-1</sup> in the IR spectra for G-g-Am-Cu<sup>2+</sup> can be attributed to N-H stretching of -CONH<sub>2</sub> (hydrogen bond). Peak near about at 2900 cm<sup>-1</sup> in the IR spectra for G-g-Am-Na<sup>+</sup> and G-g-Am-Cu<sup>2+</sup> may be attributed to O-H stretch from alcoholic -OH (hydrogen bonded) of backbone. Relative intensity of this peak (near about at 2900 cm<sup>-1</sup>) for G-g-Am-Cu<sup>2+</sup> has been reduced slightly than that for G-g-Am-Na<sup>+</sup>. Moreover, a peak appeared near about at 2500 cm<sup>-1</sup> in the IR spectra for G-g-Am-Cu<sup>2+</sup> which is almost absent in the IR spectra for G-g-Am-Na<sup>+</sup>. These indicate, -OH group from backbone of G-g-Am may involve in binding Cu<sup>2+</sup> at higher pH. Peak at 1452 cm<sup>-1</sup> can be attributed to -COO<sup>-</sup> asymmetric stretch and peak at 1342 cm<sup>-1</sup> can be attributed to -COO<sup>-</sup> symmetric stretch in the IR spectra for G-g-Am-Na<sup>+</sup>. -COO<sup>-</sup> comes from -COOH when pH is raised. -COOH probably comes from hydrolysis of -CONH<sub>2</sub> group during preparation of G-g-Am by ceric ion initiation method [4]. Similarly peak at 1422 cm<sup>-1</sup> can be attributed to -COO<sup>-</sup> asymmetric stretch and peak at 1322 cm<sup>-1</sup> can be attributed to -COO<sup>-</sup> symmetric stretch in the IR spectra for G-g-Am-Cu<sup>2+</sup> [5, 6].  $\Delta\nu$  i.e.  $[v_{\text{COO}^- (\text{asym})} - v_{\text{COO}^- (\text{sym})}]$  for G-g-Am-Cu<sup>2+</sup> is lower than that for G-g-Am-Na<sup>+</sup>. Considering group frequencies are almost independent of the structure of the compound as a whole [7] and by applying Nakamoto's reference [8], probable mode of binding of -COO<sup>-</sup> to Cu<sup>2+</sup> is bidentate chelating [6, 9].

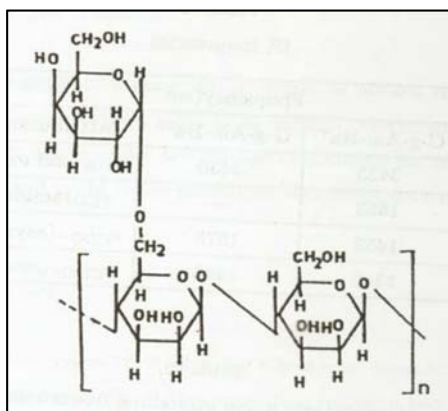


Fig 1: Structure of guar gum

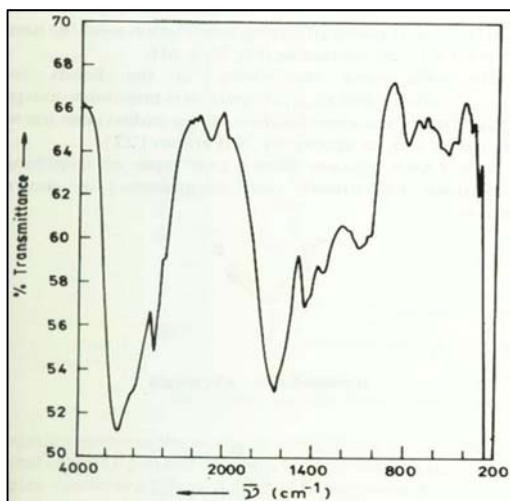


Fig 2: IR spectra for G-g-Am-Na<sup>+</sup>

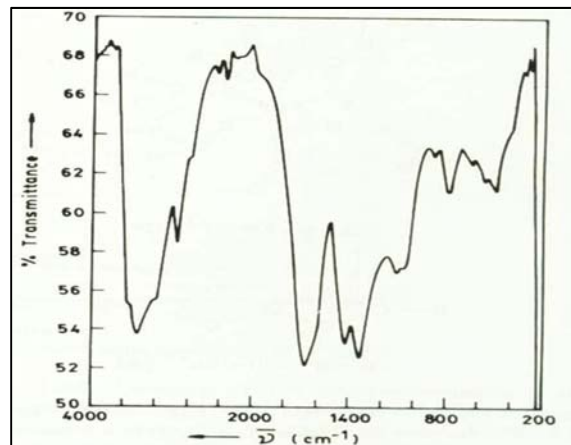


Fig 3: IR spectra for G-g-Am-Cu<sup>2+</sup>

### 4. Conclusion

Guargum is a natural polymer and hence it is cheap. But it has the defect of being biodegradable. But guar gum-graft-acrylamide has considerable biodegradation resistance. So G-g-Am was expected to be a suitable polymer for production of Y<sub>1</sub>Ba<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> superconducting material by polymeric precursor technique. But unfortunately it has been found that yttrium ion bound G-g-Am has some explosive-like character [6]. This present work indicates both backbone and side chain from G-g-Am may have role in binding Cu<sup>2+</sup> for crosslinking at higher pH.

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