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PERPUSTAKAAN UNIVERSITI MALAYA

**INFRARED SPECTROSCOPY AND  
ELECTRICAL CONDUCTIVITY OF COPPER(II) CINNAMATE  
AND IODINE -DOPED COPPER(II) CINNAMATE**

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AND IODINE -DOPED COPPER(II) CINNAMATE**

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## ABSTRACT

Copper(II) cinnamate (CC) was prepared from copper(II) acetate monohydrate and cinnamic acid. It was a light-blue powder. The Fourier Transform Infrared (FTIR) spectrum of CC, recorded as potassium bromide (KBr) disc, indicated the presence of all bonds and functional groups expected of it and showed that it exist as an equal mixture of *cis*- and *trans*- isomers.

The conductivity of CC at room temperature was  $5.22 \times 10^{-11} \text{ Scm}^{-1}$ . It showed metallic behaviour in the temperature range 78-300 K, and its conduction mechanism obeyed Mott's variable range hopping (VRH) model in the same temperature range. The density of states at Fermi level calculated based on VRH model is  $6.35 \times 10^{23} \text{ eV}^{-1}\text{cm}^{-3}$ . The hopping distance, hopping energy, and density of charge carriers at 298 K are 3.38Å, 0.0097 eV, and  $1.63 \times 10^{28} \text{ cm}^{-3}$  respectively.

CC was doped with iodine up to 20.0%. FTIR spectra for all doped samples, recorded as KBr discs, showed that iodine has no detectable effect on the structure of CC. The sample doped with 16.0% iodine showed the highest conductivity value of  $4.82 \times 10^{-9} \text{ Scm}^{-1}$  at room temperature. It showed metallic behaviour in the temperature range 78-300 K, and its conduction mechanism obeyed VRH model in the same temperature range. The density of states at Fermi level calculated based on VRH model is  $1.2 \times 10^{24} \text{ eV}^{-1}\text{cm}^{-3}$ . The hopping distance, hopping energy, and density of charge carriers at 298 K are 3.02 Å, 0.0087 eV, and  $2.5 \times 10^{28} \text{ cm}^{-3}$  respectively.

CC and CC doped with 16.0% iodine were also annealed at 50-200°C in nitrogen ambient. FTIR spectra showed that annealing at these temperature ranges has no effect on

the structure of the samples. It was found that CC and CC doped with 16.0% iodine annealed at 150°C have highest conductivity at  $1.18 \times 10^{-9} \text{ Scm}^{-1}$  and  $6.03 \times 10^{-9} \text{ Scm}^{-1}$  respectively.

## ***ABSTRAK***

Kuprum(II) sinamat (CC) disediakan daripada kuprum(II) asetat monohidrat dan asid sinamik. Sampel yang terhasil berwarna biru muda. Spektrum Transformasi Fourier Inframerah (FTIR) CC, direkod sebagai cakera kalium bromida (KBr), menunjukkan kehadiran semua ikatan dan kumpulan berfungsi yang dijangkakan, dan menunjukkan bahawa sampel wujud sebagai campuran sama banyak isomer *cis* dan isomer *trans*.

Kekonduksian CC pada suhu bilik adalah  $5.22 \times 10^{-11} \text{ Scm}^{-1}$ . Ia menunjukkan kelakuan logam pada julat suhu 78-300K, dan mekanisme kekonduksiannya mematuhi model loncatan pelbagai julat Mott (VRH) pada julat suhu yang sama. Ketumpatan keadaan pada paras Fermi dikira berdasarkan model VRH adalah  $6.35 \times 10^{23} \text{ eV}^{-1} \text{ cm}^{-3}$ . Jarak loncatan, tenaga loncatan dan ketumpatan pembawa cas, pada 298K, adalah masing-masing,  $3.38 \text{ \AA}$ ,  $0.0097 \text{ eV}$ , dan  $1.63 \times 10^{28} \text{ cm}^{-3}$ .

CC kemudiannya didopkan dengan iodin sehingga 20.0%. Spektrum FTIR semua sampel terdop, direkod sebagai cakera KBr, menunjukkan bahawa iodin tidak banyak mempengaruhi struktur CC. CC terdopkan dengan 16.0% iodin mempunyai kekonduksian tertinggi, iaitu  $4.82 \times 10^{-9} \text{ Scm}^{-1}$  pada suhu bilik. Sampel ini menunjukkan kelakuan logam dalam julat suhu 78-300K, dan mekanisme kekonduksiannya mematuhi model VRH pada julat suhu yang sama. Ketumpatan keadaan pada paras Fermi dikira berdasarkan model VRH adalah  $1.00 \times 10^{24} \text{ eV}^{-1} \text{ cm}^{-3}$ . Jarak loncatan, tenaga loncatan, dan ketumpatan pembawa cas pada 298K, adalah masing-masing,  $3.02 \text{ \AA}$ ,  $0.0087 \text{ eV}$ , dan  $2.5 \times 10^{28} \text{ cm}^{-3}$ .

CC dan CC terdopkan dengan 16.0% iodin juga disepuhlidap pada 50-200°C dalam nitrogen ambien. Spektrum FTIR menunjukkan bahawa kedua-dua sampel yang disepuhlidap ini tidak mengalami perubahan struktur yang ketara pada julat suhu tersebut. Sampel CC dan CC terdop dengan 16.0% iodin yang disepuhlidap pada 150°C mempunyai kekonduksian tertinggi, iaitu  $1.18 \times 10^{-9} \text{ Scm}^{-1}$  dan  $6.03 \times 10^{-9} \text{ Scm}^{-1}$ , masing-masing.

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