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Synthesis and Structural Properties Study of YBCO at Room Temperature

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Abstract
YBCO is a family of crystalline chemical compounds famous for displaying high-temperature superconductivity and synthesized YBCO superconductor by using solid state reaction in order to study structural properties. The structural was studied by using scanning electron microscope (SEM) and fourier transform infrared (FT-IR). Scanning electron microscope pictures show uniform and homogeneous distribution, and the effect of the doping of aluminum oxide to the composite samples decreases the grains of the image of the distortion in the shape and structure. fourier transform infrared spectrum showed that the $YBa_2Cu_3O_7$ is pure, and $YBa_2Cu_3O_7$ whichdopped with AL_2O_3 revealed perfectly.

Keywords*: YBCO, structural, aluminum oxide, pictures*

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I. noitcudortnI

The phenomenon of superconductivity was discovered by Kamerlingh Onnes in 1911, in metallic mercury below 4 K (−269.15 °C).[1] Ever since, researchers have attempted to observe superconductivity at increasing temperatures with the goal of finding room-temperature superconductor.[2]By the late 1970s, superconductivity was observed in several metallic compounds (in particular Nb- based, such as NbTi, Nb_3Sn, and Nb_3Ge) at temperatures that were much higher than those for elemental metals and which could even exceed 20 K (−253.2 °C). In 1986,[11] J. Georg Bednorz and K. Alex Müller, working at the IBM research lab near Zurich, Switzerland were exploring a new class of ceramics for superconductivity.[7] Bednorz encountered a barium-doped compound of lanthanum and copper oxide whose resistance dropped to zero at a temperature around 35 K (−238.2 °C).[3]High-temperature superconducting electronic devices have attracted extensive attentions due to their notable advantages, such as small size, low loss, low noise, high sensitivity, and easy integration with other microwave solid-state circuits. During the first half of the century after the discovery of superconductivity,[9] the problem of fluctuation smearing of the superconducting transition was not even considered. In bulk samples of traditional superconductors the critical temperature Tc sharply divides the superconducting and the normal phases.[5] The structure of high-*T*c copper oxide or cuprate superconductors are often closely related to perovskite structure, and thestructure of these compounds has been described as a distorted, oxygen deficient multi-layered perovskite structure.[4]YBCO is a high temperature superconductor whose transition temperature start at 93 K and zero resistance below the onset temperature of Tc. YBCO is a type II superconductor in that it has both Meissner effect and intermediate state. However, there are certain changes in the way the intermediate state operates. The structure of YBCO acts a significant role in superconductivity.[8] YBCO has a layered structure containing copper oxygen planes with Yttrium and Barium atoms in the crystal structure in addition. The subsequent crystal structure is related to a pervoskite with a unit cell involving of fixed cube of BaCuO3 and YCuO3. [10]

II. sdohteM dnA slairetaM

:noitaraperP elpmaS

eman redwoP	**thgieW cimotA oitaR**
3O2Y	0.4538985 gm
Ba_3Co	1.5866853 gm
OuC	0.9594162 gm
AL_2O_3	0.09 gm

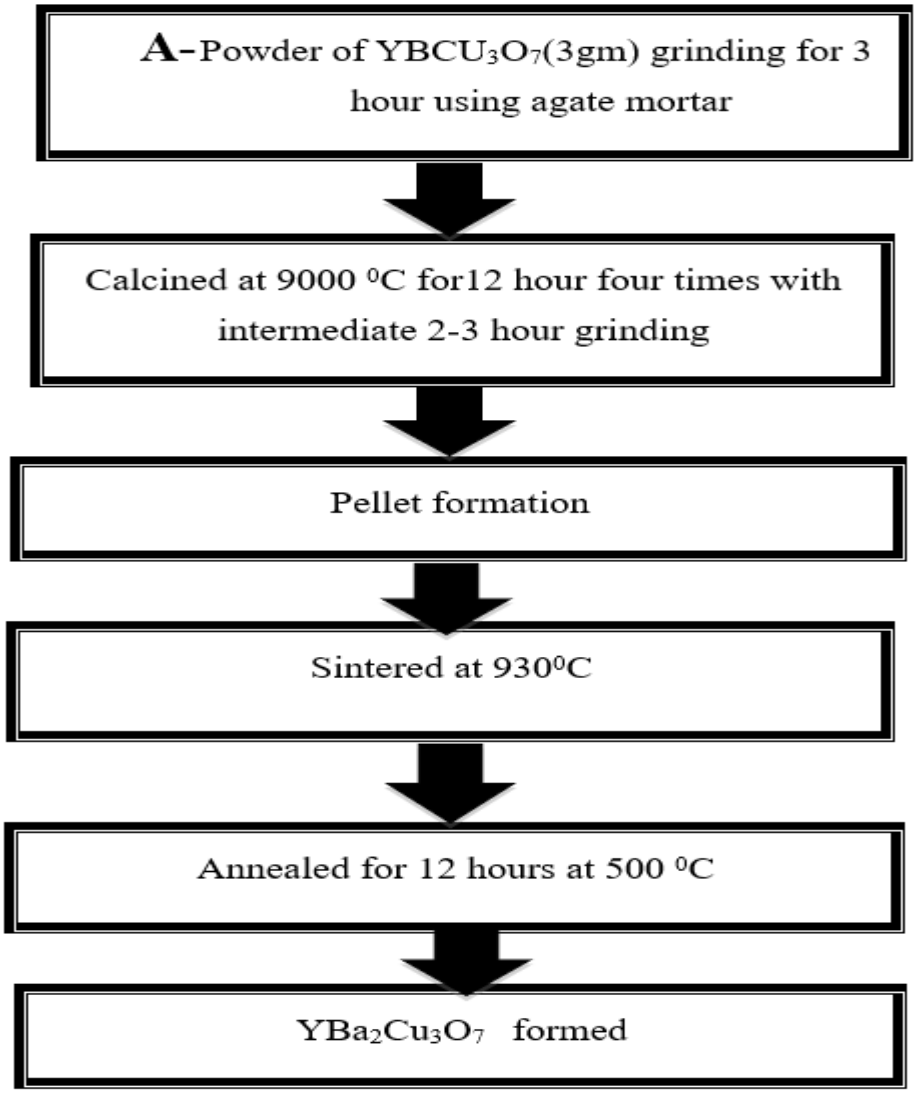
The samples YBCO were prepared by a solid state reaction by two methods [sintering samples in air, then mixing them with polymer],using appropriate weights of highly pure materials Y2O3, BaO, and CuO powders. In proportion to their molecular weights, the total weight of the compounds was calculated as follow

a. **pets tsriF**

Measuring the weight of each reactant by using a sensitive balance with4-digit type (KERN).

b. :pets dnoceS

Synthesis of YBCO superconductor:



Stochiometric amount of Yttrium Oxide, Barium Carbonate and Copper Oxide was taken as precursers to obtain the desire material YBCO.

Y2O3 + 2BaCO3 + 3CuO 2YBa2Cu3O7

The ingredients were grounded together in an agate mortar for 2-3 hrs to obtain a homogeneous mixture. After grinding, the powder was calcined at 900 0C in a muffle furnace for 12 hour and then the calcined powder was again heated for 4-5 times with intermediate grinding at the same temp. After repeated heating, the resultant powder obtained, is pressed into pellets of 1mm thickness and finally sintered at 930 0C for 12 hrs and followed by oxygen annealing for 12 hrs for Oxygen uptake and thus obtained the resultant YBCO.

c. pets drihT

Sample	$YBa_2Cu_3O_7$ (gm)	$_3O_2AL$(gm)	The percentage of doped
S_1	0.500	0	%100
S_2	0.485	0.015	%3
S_3	0.470	0.030	%6
S_4	0.455	0.045	%9

Table (1) volumetric of powder used forsample preparation

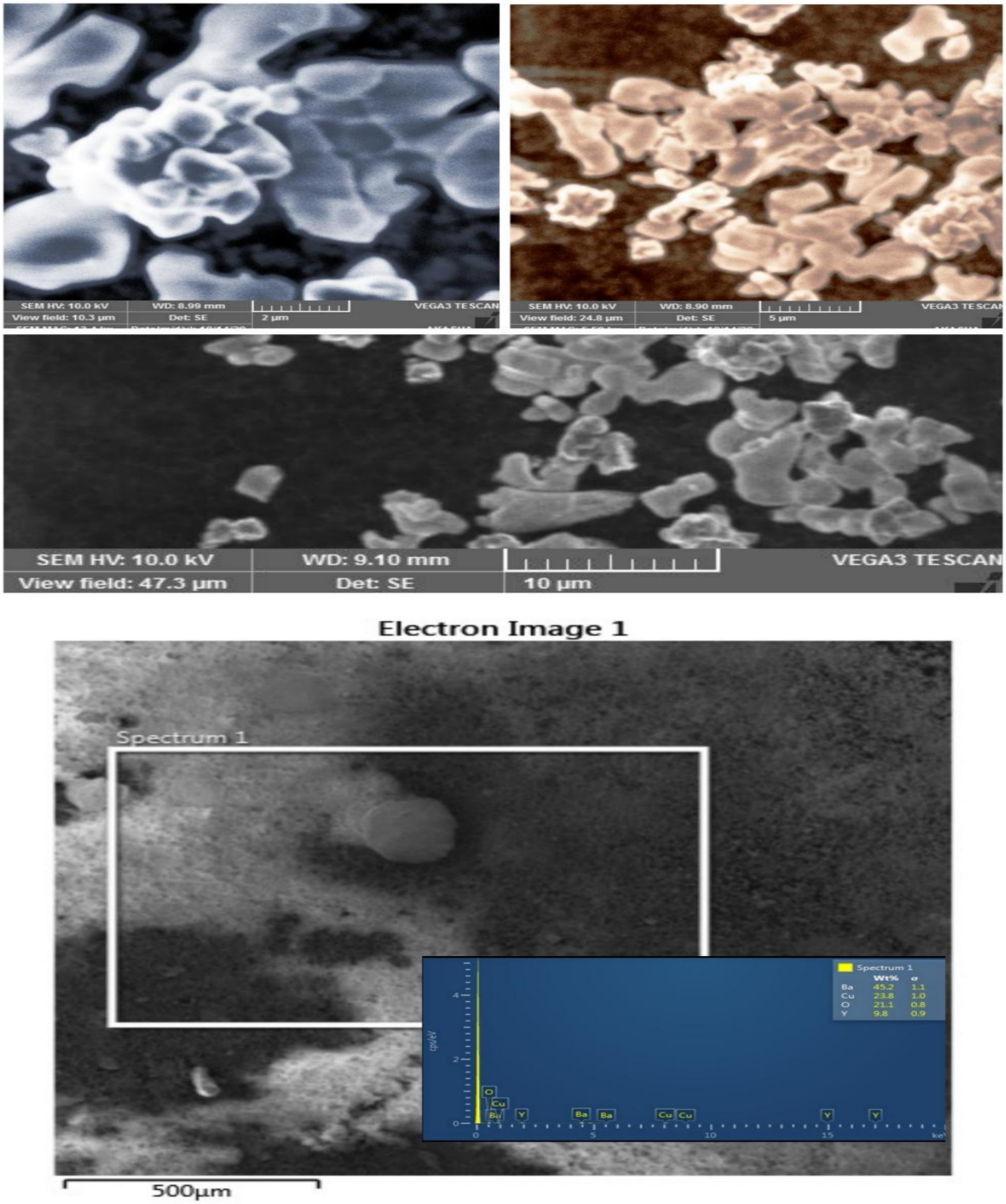
III. :dohteM latnemirepxE

The samples were collected characterized by scanning electron microscope (SEM) and Fourier transform infrared (FT-IR). the samples prepared for pure $YBa_2Cu_3O_7$and $YBa_2Cu_3O_7$ whichdopping with AL_2O_3 was analyzed at Room Temperature. Morphology of the produced powder was analysed with scanning electron microscopy (SEM), model. The sample was kept on a sample stub with carbon tape. The stub wereplased in the sample chamber of (SEM). The accelerating voltage for (SEM)examination was 10kv. The synthesized sample was analysed with FTIR spectrometry. During this process,a small amount of powder was mixed along with IR grade powder and then this powder was transferred in to a sample cup of diffuse reflectance accessory and scanned in a region about (4000-500)cm^{-1}

IV. noissucsiD dnA stluseR

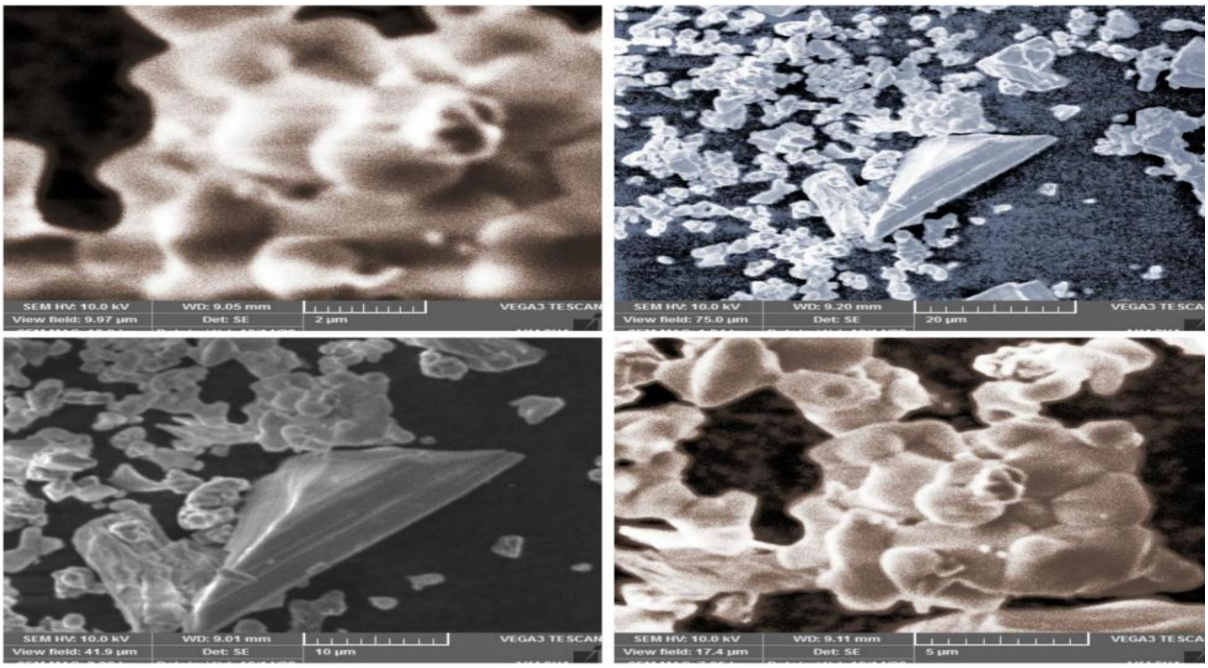
1. The results of scanning electron microscopy (SEM) for analysis samples:

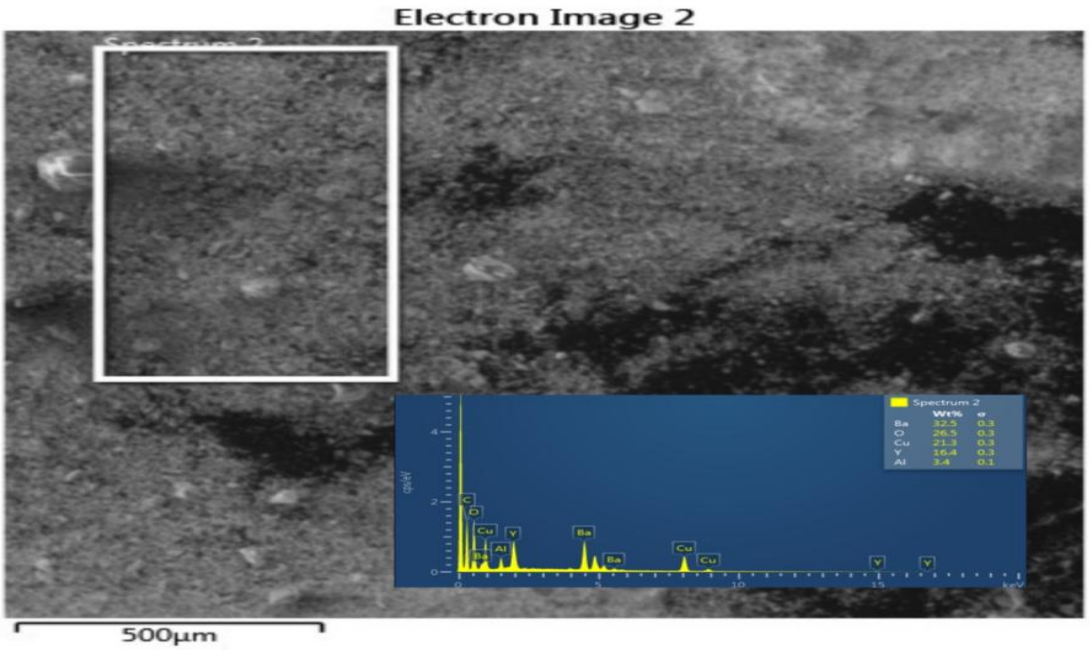
SEM analysis for pure $YBa_2Cu_3O_7$ and$YBa_2Cu_3O_7$ which dopped with AL_2O_3. the results Micrographs of fractured surface for the samples with magnification (2, 5,10,20,50,500)µm are shown in Figures.(2,3,4). The micrographs show of the one phases of and their microstructures are characterized by elongated grains with no preferred orientation (randomly orientated).The shape of some grains are the plate-like is evident, layered structures have been alignment and grains become smaller with disappear the grain boundaries. Indeed grain boundaries inside the microstructure of the samples act as the barrier to scatter the conduction of carriers, the decrease of the number of grain boundaries lead to the reduction of this insulating region and thus enhanced the grain connectivity. The increase of the Ba-O layers yielded larger grains (larger crystallinities) as shown in Figs (1).



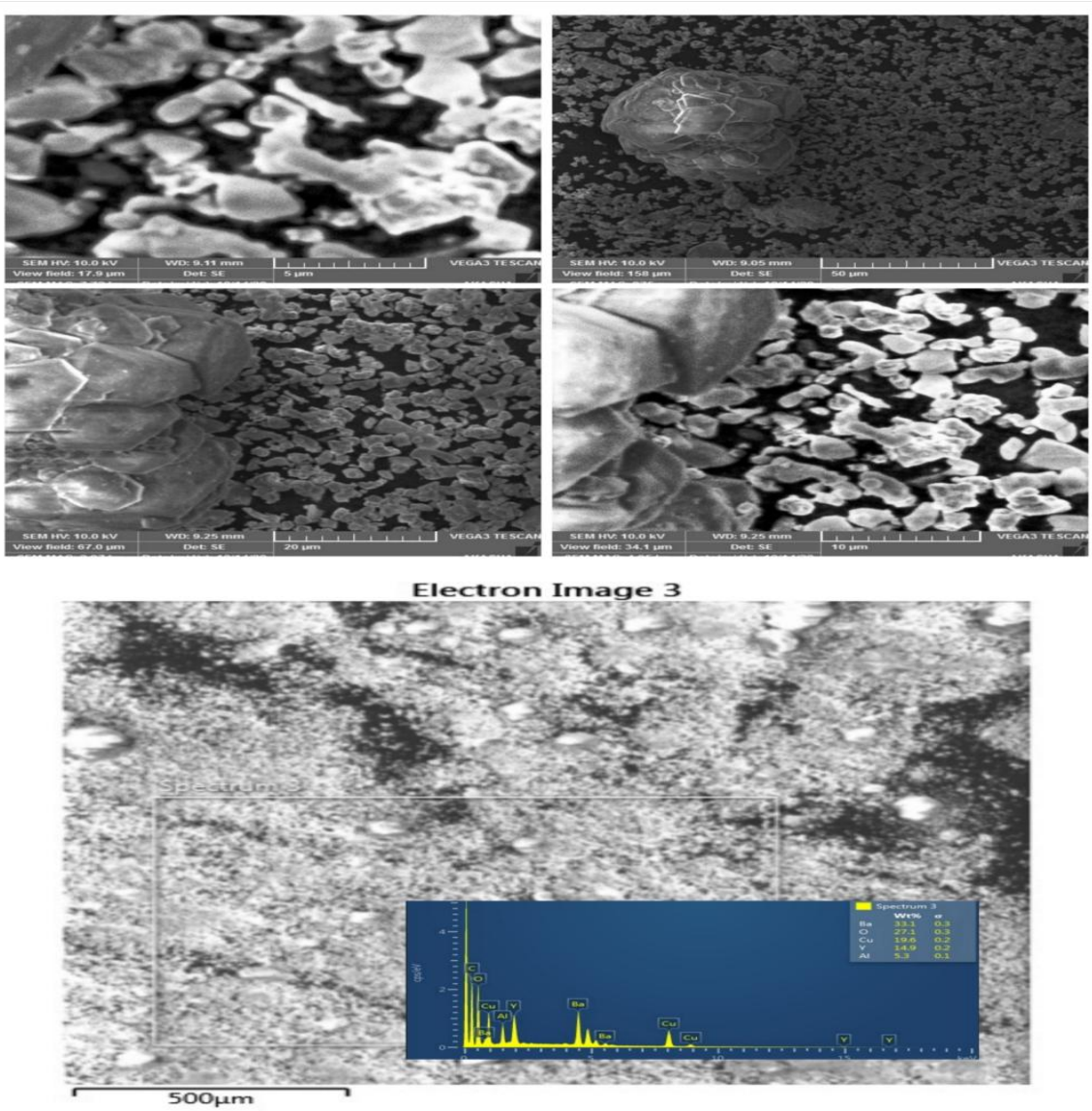
Figs. (1): SEM micrographs of the fracture surface of composites of pure YBCO

The figures (2)(3) shows the results of aScanning Electron Microscopy (SEM) for $YBa_2Cu_3O_7$ doped with AL_2O_3,where the images are shown as homogeneity increases and the crystal growth is practically evident.





Figs. (2): SEM micrographs of the fracture surface of composites of pure YBCO



Figs. (3): SEM micrographs of the fracture surface of composites of YBCO which dopped with AL_2O_3

2. The results offourier transform infrared (FT-IR) for analysis samples:

The IR spectroscopy has been studied for pure $YBa_2Cu_3O_7$ and doped with AL_2O_3Infrared spectrum can be affected by several factors in the whole regionfrom 500-4000 cm-1 such as the influence of different ambient conditions (humidity , temperature and pressure in the sample preparation), storing and processing that take place on the samples .The amount of moisture in the Potassium bromide matrix varied in the individual laboratories . The Sample prepared at room temperature is shown in Figure (4,5). where the percentage of transmittance is plotted as a function of wave number (cm-1) The characteristic of FTIR can distinguish between sulfoxide and carbon dioxide in the (1000 -2500) cm-1 region of the spectrum .This region of the spectrum is very important to distinguish and diagnostics the superconductor in both cases of doped and undoped.

The band's range (Cm-)	Assignment	Pure	Doped
422.52 – 500	(C-I) halo compound, stretching, strong	**418.52 449.38 474.46**	**418.52 422.38**
500 -750	(C-Br) halo compound, stretching, strong	**557.39 634.45 667.32 692.40**	**530.39 692.40**
750 – 1000	(C-C) bending, alkene, strong,vinylidene	**856.34**	**856.34**
1000 -1250	(S-O) stretching, strong,sulfoxide	**1058.85**	**1058.85**
1250 – 1500	(O-H) bending, medium,phenol	**1390**	**1390**
1500 – 1750	(C=C) stretching,strong,α,β-unsaturated ketone	**1556.45**	**---**
≈ 1750	(C=O) stretching, strong,δ-lactone,esters	**1749.32**	**1749.32**
2000 – 25000	(O=C=O) stretching, strong,carbon dioxide	**2356.85 2451.36**	**2451.36**

Table (2): The list of the observed peaks for the prepared pure $YBa_2Cu_3O_7$ and doped with AL_2O_3 at roomtemperature

Table (2) show the main transmission bands of the pure $YBa_2Cu_3O_7$ and doped with AL_2O_3 . The observed peak at 418.52 cm^{-1} is a measure of the amount of iodo whichwas returned to the used monomer (aniline hydrochloride). While the peak at 856.34cm^{-1} could be related to the alkene in the case ofundopped (pure), but it possible to return to each of the alkene and to vinylidene compounds which resulting from the dopant acidic. The most important characteristic bands of $YBa_2Cu_3O_7$ is the band observed at a wavelength of 1058.85 cm^{-1} and the band at 2451.36cm^{-1},which represents the sulfoxide and carbon dioxide, respectively. Finally theother bands which located they presence the vibration bands of water molecules in most of the spectra shown in figure (5) correspond to a higher humidity during measurements that were made. When we comparing a doped with AL_2O_3 in fig (5) with the purepeaks Fig (4) we notice the change in intensity, no shifting in theposition of the band, and the peak for sulfate group were noticed whichmean the doping happened in $YBa_2Cu_3O_7$ chain.

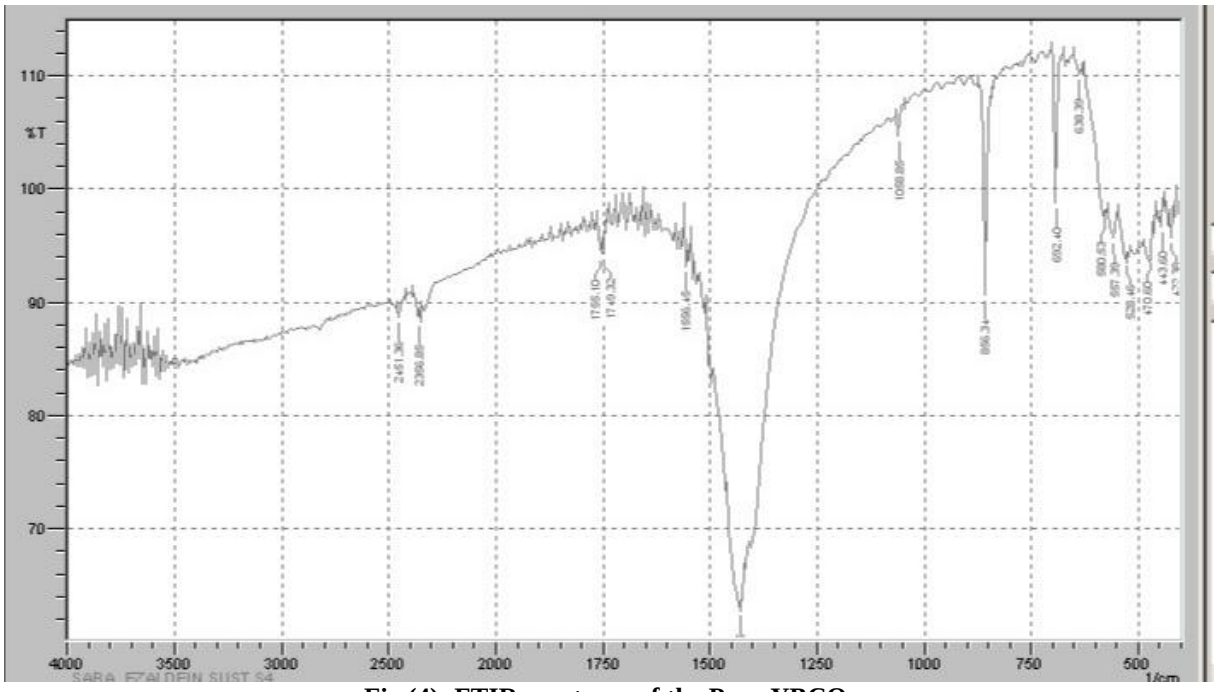


Fig (4): FTIR spectrum of the Pure YBCO

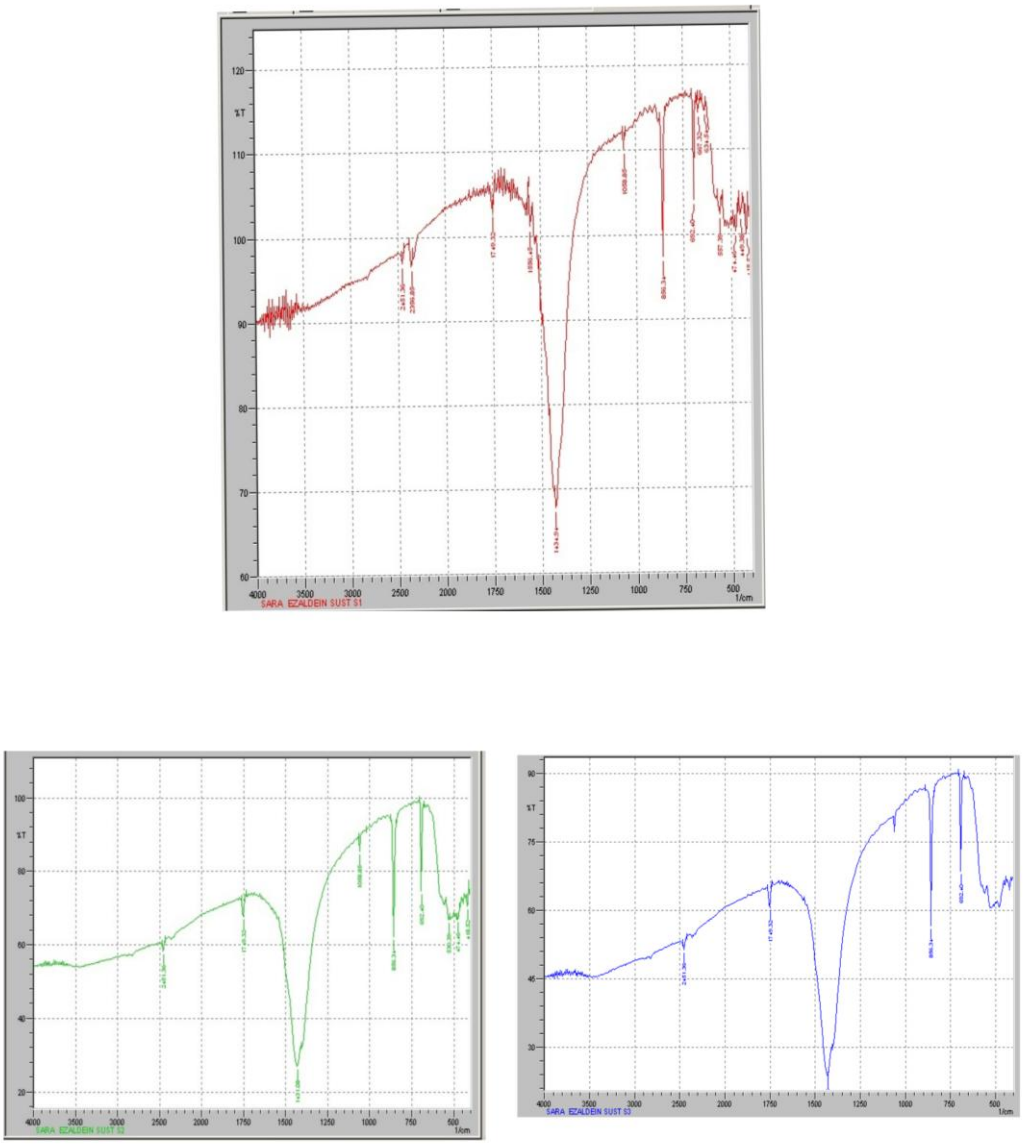


Fig (5): FTIR spectrum of the YBCO which dopped with AL_2O_3

V. noisulcnoC

Through this study, The YBCO superconductor is prepared successfully via solid state reaction method. The fourier transform infrared spectrum showed that the $YBa_2Cu_3O_7$ is pure, and $YBa_2Cu_3O_7$ whichdopped with AL_2O_3 revealed perfectly. And SEM micrographs for pure $YBa_2Cu_3O_7$ that doped with AL_2O_3 with difference magnification (2μm, 50μm, 10μm, 5μm, 20μm), results images are found to have uniform and homogeneous distribution, and the effect of the doping of aluminum oxide to the composite samples decreases the grains of the image of the distortion in the shape and structure.

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