Preparation of Polymer Nano-composite Materials for Microwave Sensor Application

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Abstract

In this study, prepared nanocomposite materials made of polyester were prepared with a fixation hardener ratio of 0.1 g per 10 ml of polyester. This percentage was constant in all samples and addition of both chlorophyll(Cll) and lead oxide (PbO<100nm) as well as lead oxide with chlorophyll by weight percentage (0.2 ,0.5, 0.2 (Cll) with 0.5(PbO)wt.% receptivity, then study coefficient of loss of reflectivity of all samples where the results indicated that most prepared materials correct for use attenuation materials of microwaves where is reflection coefficient of all samples larger than (10dB) this show that absorption of composite materials consistence larger than 90%, then study reflection coefficient and also definition complex permittivity in the range frequencies (3-5)GHz where observed that value of the complex permittivity larger than one $(\mu_R > 1)$.

Keywords: Nano-composite, Microwave Sensor, Application

Introduction

One of the most important uses of nanoparticles with a polymeric basis is to protect people from the side effects of radiation emitted from the mobile because the radiation caused by the excessive use of mobile phones is very dangerous, because the radio signals from cellular phones are considered carcinogens - that can cause cancer and there are symptoms And disturbances occur as a result of mobile phone radiation such as dizziness, insomnia, Parkinson's disease, brain tumors, and many more [1,2]. Mobile phones use electromagnetic radiation in the microwave or microwave range, and other digital wireless systems, such as data and communications networks, produce similar beams. The International Agency for Research on Cancer (IARC) classifies mobile radiation based on the IARC scale into category 2b (may cause cancer). Which means they may pose a risk of cancer [3,4]. The constant consideration of smart phones is full of damage, but looking at smart phones continuously causes an internal headache which causes lack of sleep. According to optics specialist Andy Hepworth, ultraviolet radiation from smartphones can cause damage to the back of the eye, and continuous exposure to these rays turns on the mood, causing discomfort and lack of sleep [5]. The 2012 study found that 66% of people are worried or afraid to lose their phones or move away for a short period, which leads to the use of smart phone on the charger and may cause radiation from the charger to the phone damage in the long term brain and brain [6,7]. Mobile phone is one of the basics of the present day, has spread around the world speed of the missile, and gradually developed to become a laptop, you can use throughout your day tirelessly and tired. But for all the price and science also a double-edged weapon [8]. Phones Portable as a time bomb unfortunately due to its great effects Harmful to our health, mobile devices open in the bedrooms cause insomnia and excessive use leads to brain damage and heart weakness The mobile inventor of the German chemist Friedhelm Weinhurst warned of the risk of leaving mobile devices open in the bedrooms on the human brain , Said in a private meeting

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with him in Munich, that keeping these devices or any transmitters or receiving space in the bedrooms cause a state of insomnia, anxiety and lack of sleep and damage to the brain, which in the long term to destroy the immune system in the body [9,10]. He stressed in a press statement that there are two values for the frequency of radiation emitted from the initial mobile 900 MHz and 1.8 MHz second, which puts the human body to many risks, pointing to mobile power stations equivalent to the power of radiation from a small nuclear reactor, and the electromagnetic waves resulting from the mobile Stronger than x-rays that penetrate all organs of the body [11,12]. On the one hand, a group of scientists in Sweden, Germany, Australia and the United States confirm the damage caused by these waves, On the skin, on semen, on the immunity of the body and on the disappearance of insects [13]. In our analysis the microwave loss materials have been characterized in terms of the electrical permittivity, which describes the interaction of a material with an electric field and in general is complex quantity($\varepsilon_R = \varepsilon' - j\varepsilon''$) [14]. According to the theory of complex permittivity, when an electromagnetic field propagates within dielectric material, the electric field induces two types of electrical effects, i.e. conduction and displacement currents. The effect arising from free electrons (conduction current) gives rise to powerless, which is related to the imaginary permittivity (ε''); the interaction with bound charges (displacement current) induces the polarization effect, which is described by the real permittivity (ε') [15]. Therefore, an increase of the real part of the complex permittivity can be mainly ascribed to dielectric relaxation and space charge polarization effect, whereas an increase of the imaginary part of the complex permittivity can be attributed to the enhanced electrical conductivity of the material. The paper is arranged in four main sections. the experimental part, (in Section 2),Vector Network Analyzer(VNA) as shown in (Section 2.1),the result and discussion as shown in (Section 3), the results for optical microscope as shown in (Section 3.1), FT-IR measurements as shown (Section 3.2), microwave absorption properties as shown in (Section4),Loss Reflectivity as shown in (Section 4.1), Reflection Coefficient as shown in (Section 4.2), complex permittivity(ε_R) as shown in (Section 4.3),complex permittivity(μ_R) as shown in (Section 4.3).

Experimental Part

In order to measure the microwave properties of the composite materials by means of Vector Network Analyzer (N5230C Agilent PNA-L) in the waveguide method for (3-5) GHz , In this research, the following materials have been used where you work on selecting the best ratio of hardener by selecting 10 ml of polyester to be fixed for all samples and add a percentage from hardener of polyester where the number of samples to the college in this work is (4) samples , is hardener in fixed percentage (0.1,0.2,0.3,0.4) wt.% . To choose the best ratio to be fixing in all samples After completing the samples required to select the appropriate ratio, the hardness of the samples was measured using the hardness measuring device (Shore-A)[16,17] ,Where the hardness of the samples was (71, 70, 69, 68) so the first ratio was chosen based on the hardness measurements to be constant in all samples a first sample was then two step for work the second sample by adding a chlorophyll with different weight ratios (0.2, 0.4, 0.6, 0.8) wt.% where the best chlorophyll was selected based on optical characteristic measurements using a device(UV-Spectrophotometer) to select a sample with high absorption and transmittance of up to 60% for visible light where selection of the first sample with a concentration (0.2)wt.% of chlorophyll was then three step for work the three sample by adding a Lead oxide (PbO,>100nm) with different weight ratios (0.1, 0.3, 0.5) wt.% where the best PbO ratio was selected based on optical characteristic measurements using a device (UV-Spectrophotometer) to select a sample with high absorption and transmittance of up to 60% for visible light where selection of the three sample with a concentration (0.5)wt.% of PbO was then four step for work the four sample by adding a best ratio of chlorophyll with best ratio of PbO and then The samples were then prepared and configured to test the microwave absorption using a device Vector Network Analyzer (N5230C Agilent PNA-L) where the samples were cut by 1 cm based on the size of the required waveguide.

Vector Network Analyzer(VNA)

Before the network analyzer, determining the reflection coefficient of a circuit required you to manually calculate the phase of the reflection coefficient one frequency at a time on a piece of paper. This manual

process required youth first find the maxima and minima of the standing voltage wave in a slotted line and repeat this process for all frequencies of interest. It is safe to say that if the vector network analyzer (VNA) had not been created, the high frequency community would look very different today. Today, the VNA characterizes high-frequency passive and active devices in their linear mode of operation by measuring their network parameters, called S-parameters, as a function of frequency. Over time, VNAs have been extended in hardware and in capability to also measure noise parameters and nonlinear characteristics, including compression, intermodulation, and hot S22 measurements1. As a result, the VNA evolved into [18].

Result and Discussion

The optical microscope

Figure (1) show the images of (Pure, Cll, PbO, Cll+ PbO) nanocomposites materials by two magnification power, taken for samples at magnification power(10x). However, shows a clear difference to the samples as shown in the pictures. When addition proportions of Cll in films composites, the chlorophyll form a continuous network inside the polymers. When addition proportion of (PbO) nanoparticle continuous network inside the polymers and best film. This network has paths where charge carriers are allowed to pass through the paths, causing a change in the material properties. This is consistent with the results of researchers.
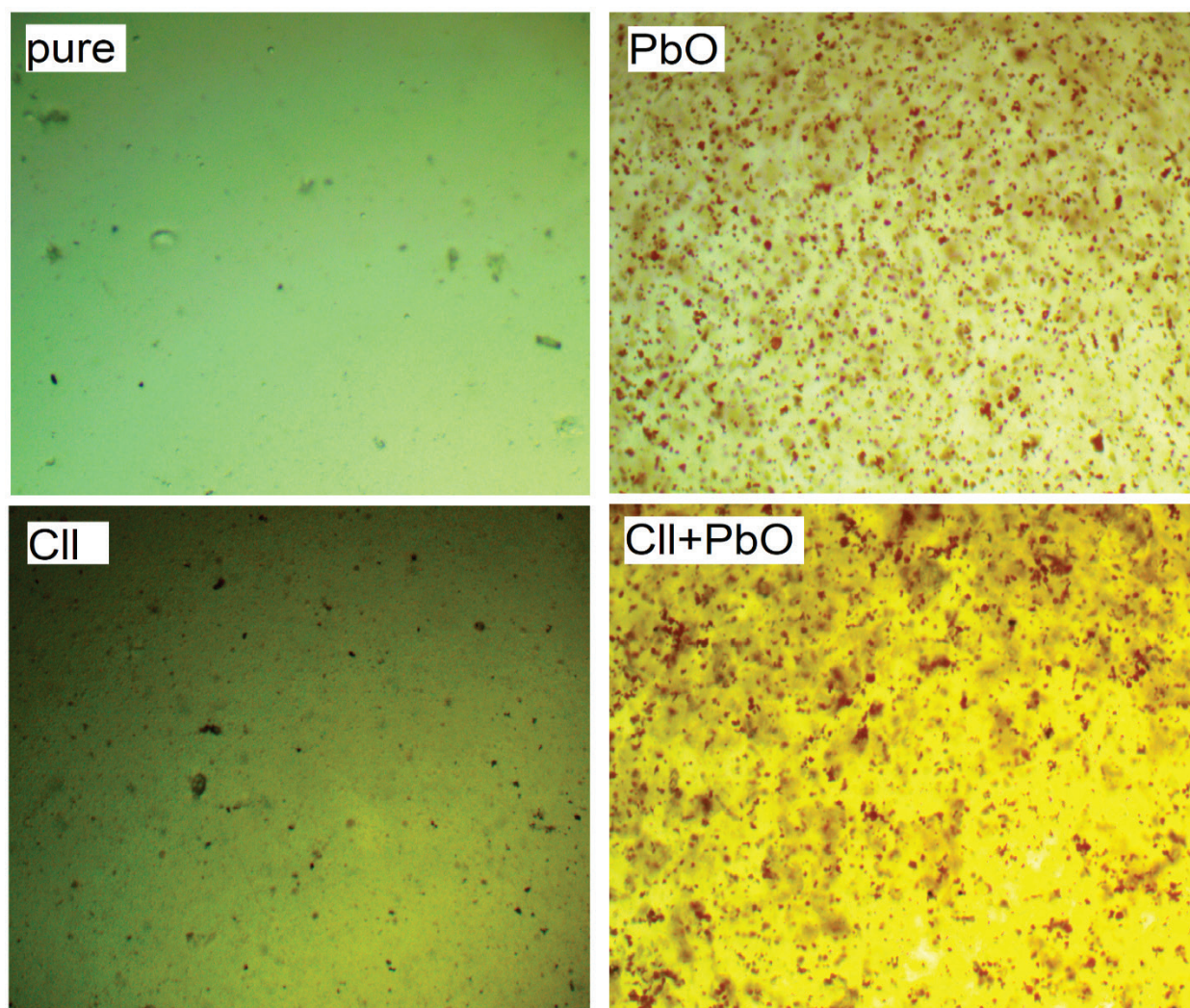

Fig. 1: Photomicrographs (10X) for (Pure, Cll, PbO, Cll+ PbO) composite materials

3.2 Fourier Transforms Infrared Spectroscopy Testing (FT-IR)

The Fourier transforms infrared spectroscopy (FT-IR) spectra of pure (pure, pure-Cll, pure-PbO, pure-Cll-PbO) and doped films are shown as Table (l).

Table 1: (FT-IR) spectra of pure (pure, pure-Cll, pure-PbO, pure-Cll-PbO)

1-pure(polyester- hardener)	10ml- 0.1 wt.%	Fig.3(A)
2- pure -Cll	0.2wt.%	Fig.3(B)
3- pure-PbO	0.5wt.%	Fig.3(C)
4- pure-Cll-PbO	(0.2,0.5) wt.%	Fig.3(D)

All spectra exhibit the characteristic absorption bands of pure. It can be noticed that some observable changes in the spectral features of the samples in the range (1718–1068) cm^{-1} (fingerprint region) apart from new absorption bands and slight changes in the intensities of some absorption bands. The new bands may be correlated likewise with defects induced by the charge transfer reaction between the polymer chain and the nanomaterials. The vibrational peaks for pure at (3254.63, 2907.09, 2852.73, and 1083.93) cm^{-1} are assigned to O–H stretching, C–H stretching, C=O stretching, C–H bend of CH2, and CH rocking of (pure-Cll), respectively and another vibrational peaks for concentrations of nanocomposites. further, the vibrational peaks found in the range (1718-1068) cm^{-1}may be attributed to nanoparticles with polymers which indicate that nanoparticles doped in the (Cll, PbO) polymers matrix.
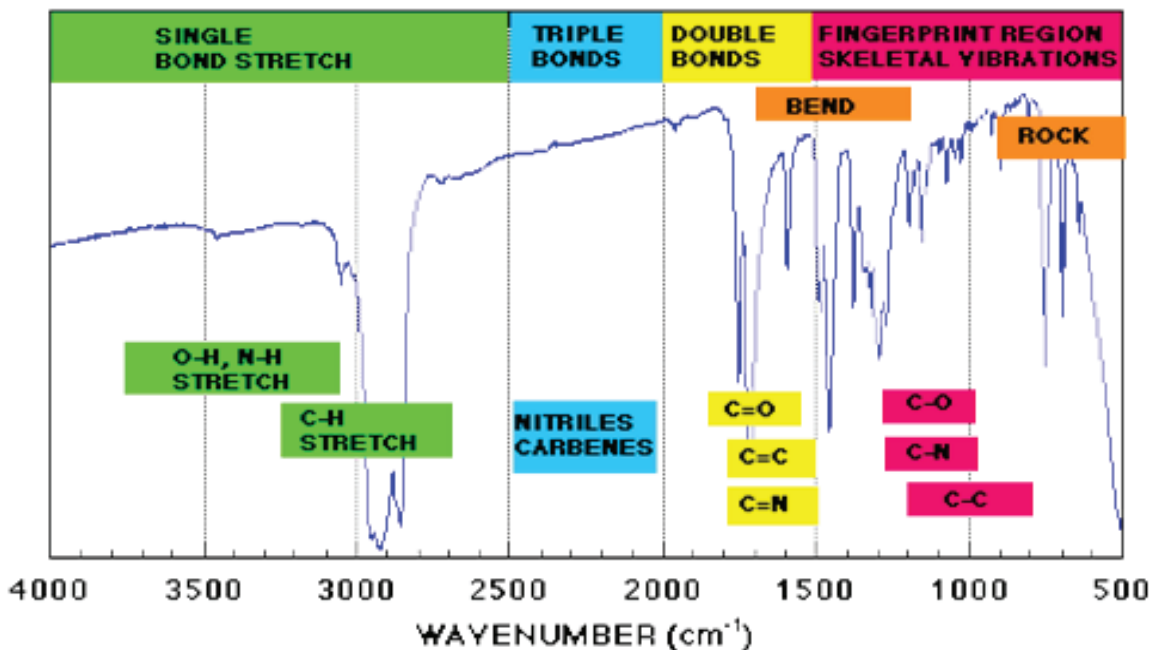
Fig.2: (FT-IR) Bands regions

Fig.3 (FT-IR) for A- pure sample 0.1 wt.%, B-(pure-Cll) 0.2wt.%, C-(pure-PbO) 0.5 wt.%, D-(pure-Cll-PbO) 0.2,0.5 wt.%

Microwaves absorption properties

Loss Reflectivity

Fig.(4), show that the loss of reflectivity in the first sample without the addition(pure) of the fries are few the greatest loss of reflectivity is confined to frequencies (3-3.2) GHz is limited ((-50- (-39) dB) but after the addition of chlorophyll(ll) for the Sample in the case observed The energy of reflection at frequency (4.5-3.5) GHz equal ((-30 – (-43) dB). The greatest loss of reflection energy is limited (-43dB) at frequency (3.15) GHz There are values ranging (-24dB, -15dB) at frequencies (3.5-3.8) GHz and add the addition of lead oxide(PbO) The greatest loss of reflectivity is confined to frequencies (3-4) GHz is limited ((-33- (-15)) dB and add the addition of lead oxide(PbO) with chlorophyll(Cll) The greatest loss of reflectivity is confined to frequency (3.7) GHz is limited (-49) dB .This means that there is high absorption of microwaves in range (3-5) GHz.
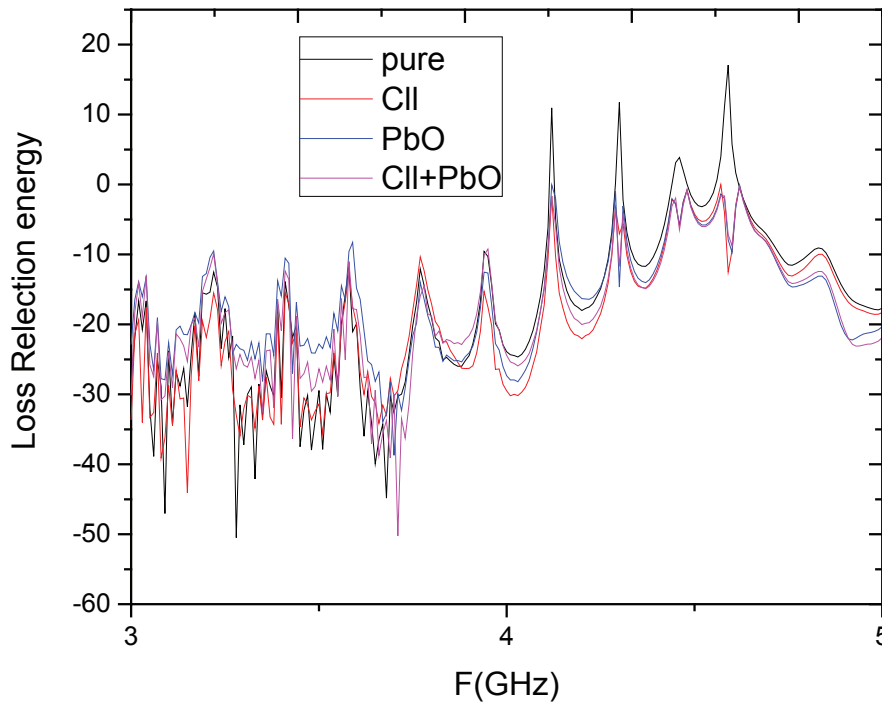

Fig .4: Shows the reflection Coefficient with frequency when (pure, Cll, PbO, PbO+Cll) receptivity

Reflection Coefficient

In order to obtain materials with high attenuation of the electromagnetic waves, the coefficient of reflection should be reduced to the lowest possible value. As shown in Figure (5), the relationship between the reflection coefficient of the prepared materials where we observe that the behavior of the reflection coefficient is similar to the extent A large measure between the loss of energy reflection and frequency where we note that the lowest value of the reflection coefficient corresponds to the highest value of the loss of reflection energy and this is the axioms because the coefficient of reflection is calculated through the relationship.

RC = 20 LOG (Γ), where Γ represents the loss of reflective energy of the fallen beam. Thus, we have obtained materials with low reflection coefficients that can be used as electromagnetic wave modifiers in the (3-5) GHz package
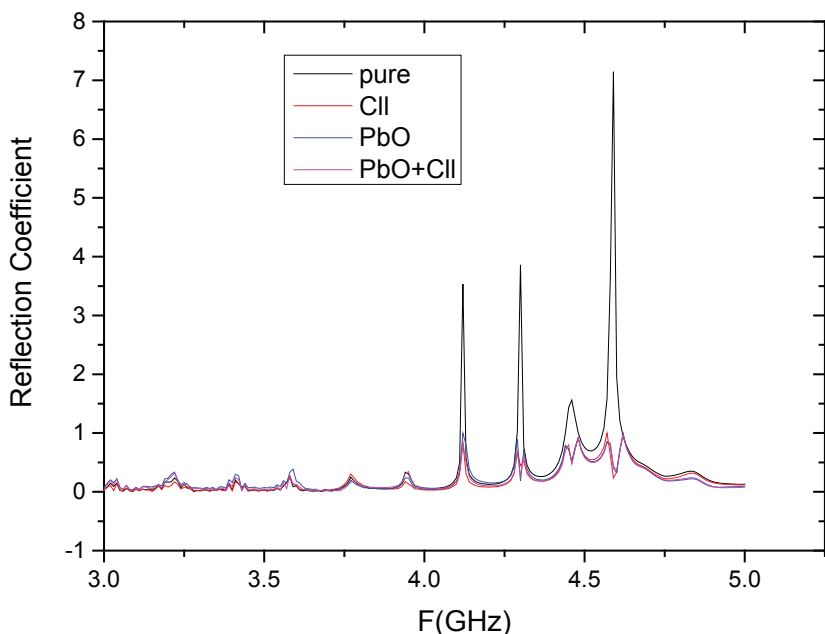
Fig .5: Shows the loss of reflection energy with frequency when (pure,Cll, PbO, PbO+Cll) receptivity

Complex permittivity ($\varepsilon_R \varepsilon_R$)

Fig.(6), show the behavior of complex Permittivity with frequency in the restricted range of (3-5) GHz where we observe that the behavior is similar to the behavior of the attenuation coefficient because the calculation of compound permutation was calculated using the attenuation coefficient Where we note the values at frequency(4) GHz when (pure, Cll ,PbO,Cll+PbO) is ($\epsilon_r = (10.26, 13., 12, 9.2) \epsilon_r = (10.26, 13., 12, 9.2)$ respictivity
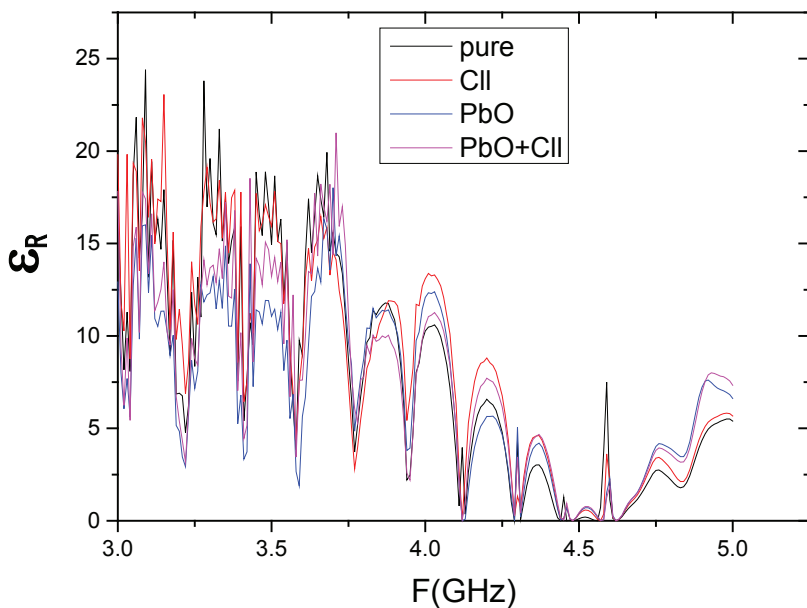

Fig. 6: Shows Complex permittivity ($\varepsilon_R \varepsilon_R$)with frequency when (pure, Cll, PbO, PbO+Cll) receptivity

Conclusions

In this study, it is possible to use composite materials to attenuate the microwave waves and absorb them completely. The results showed that the susceptibility of these materials to the absorption of microwaves is large, up to 90% observed and obtained high absorption so that the material is used to disperse these waves and reduce the impact on people, which can be used for screen mobile and as is known, the mobile produces electromagnetic radiation may be harmful to humans because of thermal effects, especially on the eye as well as mobile towers And the towers of the Internet and wireless communications send these waves within the range of frequencies (3-5)GHz so the use of this material for screen mobile to absorbs all these waves and attenuate, which is reflected positively on human life.

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Conflict of Interest: None to declare.

Ethical Clearance: All experimental protocols were approved under the College Education for pure science, Iraq and all experiments were carried out in accordance with approved guidelines.

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