Research on absorbing performance of activated carbon

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Abstract. The absorbing properties of activated carbon were studied and tested by making use of RCS in “the reflectivity testing measurement of radar absorbing material” of GJB 2038-94 in this work. The effect of electromagnetic parameters and thickness on absorbing properties of materials was discussed. The results indicate that in the whole 12–18 GHz frequency band, the dielectric constant decreases with increasing frequency, the dielectric loss angle tangent with the frequency gradually increased, and the activated carbon is a kind of anti magnetic media, but it also has some paramagnetic. The sample thickness has little effect on the wave absorbing property in the 12–18GHz frequency band;

1. Introduction

The stealthy weapon in the Gulf War was applied to the actual combat for the first time and showed the enormous might that caused countries to paying great attention developing stealthy and anti-stealthy technology, and promoted the development of the absorbing material. Meanwhile, with violent development of electronic technology, various kinds of new-type radars, advanced detector and accurate guidance weapon come out one after another. Under the condition, the threat which future weapon system of battle field, especially some large-scale weapon to fight, for instance, plane, guided missile, naval vessel, tank, etc, would face increase day by day. So, to develop the new-type high-performance radar and the absorbing material become focal point of stealthy technological research and development. The research of the stealthy materials which are required to have characteristic with light weight and a good adaptability is classified as key development projects by the department defense of U.S.A[1-3]. Structural radar absorbing materials (SRAMs) are developed on the basis of the advanced composite materials that are dual functional composite materials, to stealth and bearing, forming a variety of complex shape parts, such as the wings, tail, inlet, which is the main development direction of absorbing material. Compared to Radar absorbing materials (RAMs), SARMs have no limitation of thickness, so the design and calculation for SRAMs become easier [4−8]. US advanced stealth fighter-bomber F-117, the strategic bomber B-2, fighter YF-22, the YF-23, F-22 and advanced cruise missiles were used a lot of carbon fiber, carbon / Kevlar fiber or carbon / glass fiber hybrid fiber as a reinforcing material structural absorbing materials[9-10].

Activated carbon with high specific surface area and the adsorption capacity has long been widely used in purification, separation, gas and liquid water treatment, air purification and resource recovery and so on. Influence the adsorption performance of the two main factors: one is the pore structure, such as specific surface area, pore size and pore distribution. Typically, the amount of the activated carbon adsorbent material is proportional to its specific surface area; On the other hand is the surface chemical structure of surface functional groups, such as the variety and content and so on; Activated carbon for gases and liquids have excellent adsorption performance, but few people study its absorbing properties, The electromagnetic wave absorption properties of activated carbon is expected
to be highly efficient light absorbing material, which has important theoretical and practical significance. Resin based spherical activated carbon with black gloss and good sphericity, bulk density in 0.350~0.480g / mL, specific surface area of 900-1500m²/g, pore volume 0.6mL / g or more has excellent adsorption properties of molecules; Wave transparent material coated on activated carbon (epoxy resin), combined with aluminum prepared into structural absorbing materials were tested and analysis of microwave absorbing properties. On this basis, absorbing material preparation with different thickness, the activated carbon absorbing materials will be further improved.

2. Experimental procedure

2.1 Experimental materials and equipment

Experiment equipment contains BL-220H type electronic balance, SL79-164 type vacuum resistance furnace, LT-1005 type low temperature and constant temperature box, KQ-100KDE type high power CNC ultra wave washer, WYK-15020-H DC regulated power supply and so on. Anhydrous ethanol, phosphoric acid, chromic acid, 6101 epoxy and resin polyamide were used in the experiment. Both of them are analytically pure.

2.2 Experimental procedures

2.2.1 Surface degreasing treatment

After annealing, put the aluminum sheet into absolute ethanol ultrasonic cleaning 10min, removal of grease from the surface, repeated washing with deionized water, to place in a 5% sodium hydroxide solution in the ultrasonic cleaning 5min, to remove the surface oxide film, and finally, repeatedly washed with deionized water, drying.

2.2.2 Preparation of wave-transparent materials

Wave transmitting materials were prepared by Epoxy resin and curing agent polyamide put in the oven heated at 60°C, take out after 5min. The adhesive epoxy resin and curing agent polyamide 2:1 by mass mixed, manual stirring 5 min, prepared by wave-transparent material.

2.2.3 Preparation of structural absorbing material

First 180mm×180mm aluminum box was made by the aluminum plate, the high were made 10mm, 15mm, 25mm; Activated carbon placed in the oven for drying, temperature is 80°C, time is 12h. Brush a layer of adhesive on the bottom of the aluminum case for aluminum plate and activated carbon bonded together better, formed absorbing material structures of different heights; at last, brush a layer of wave-transparent materials on the activated carbon surface, the thinness is between 1~2mm; Samples were dried in the oven at 60°C. Backup.

3. Experimental results and discussion

3.1 Absorbing mechanism of spherical activated carbon
Electromagnetic waves in the electric and magnetic fields are always attendant[11], a changing magnetic field gives rise to a changing electric field, both of alternating with each other, accompanied by forward. Change the direction of the electric field caused by the accompanying magnetic field must change direction, according to lenz law; the changing magnetic field will produce induced current. So whether the incident magnetic field or magnetic field interference will produce induced current. The figure 1 shows that packing globular activated carbon forms porous structure.

3.2 The electromagnetic parameters of activated carbon

The results in activated carbon electromagnetic constant are shown as figure 2. From fig. 2 (a) can be seen the dielectric constant of the active carbon has high, the real part of permittivity in more than 8 and the imaginary part is about 6 below 6 GHz frequency band. But in the whole 12~18 GHz frequency band, the dielectric constant decreases with increasing frequency, the dielectric loss angle $\tan\delta_E$ tangent with the frequency gradually increased, increasing from 0.5 in the 12GHz to 0.8 in the 18 GHz, which is helpful to broaden the spectrum.

The figure 2 (b) it can be seen that the activated carbon permeability is very small, the real component is between 0.7- 0.9, and the imaginary part is almost zero, the activated carbon is a kind of anti magnetic media, but it also has some paramagnetic.
3.3 Effect of thickness on absorbing property of activated carbon

The thickness of the material has an impact on its absorbing properties in general, so analyzed the reflectance curves of different thicknesses activated carbon. The thickness of activated carbon were 3mm, 5mm, 10mm as a model, the bottom lining plate is aluminum plate. As shown in fig3, the changing trend of the reflectivity curves of three kinds of samples are the same, with the increasing of the microwave frequency increases, and the wave absorbing performance is very similar, the sample thickness has little effect on the wave absorbing property in the 12~18GHz frequency band. When the thickness of activated carbon is 3mm, the maximum amount of absorbing is up to -3.6dB, the entire band absorption are more than the -3dB, to illustrate the activated carbon exhibited excellent microwave absorption properties. With the increase of the thickness, wave absorbing property increases, when the thickness is 5mm, the maximum absorbing reached -4.3dB, which is better than the microwave absorbing property of activated carbon of thinness 3mm, increasing the amount of less than -0.8dB, absorption performance improvement is small; But when the thickness is more than 5mm, the thickness have almost no effect on the wave absorbing property, compared with the absorbing properties of thickness of 5mm, the10mm absorbing performance does not change.
Accumulation of activated carbon on attenuation of electromagnetic wave mainly comes from its pore structure, when the electromagnetic wave incident on the interface of activated carbon, part of the electromagnetic wave reflected by activated carbon, the other part of the electromagnetic wave transmitted hollow sphere of activated carbon into the pore (gap between the ball and the ball) internal communication. The structural absorbing material of activated carbon makes electromagnetic wave transmittance occur multiple interface reflection, which formed a large attenuation and absorption greater loss.

4. Conclusions
This paper analyzes the absorbing mechanism of activated carbon, research influence of thickness on absorbing property of activated carbon, for structural activated carbon absorbing material research and design providing a good theoretical basis.

1. The dielectric constant of the active carbon is high, the real part of permittivity is more than 8 and the imaginary part is about 6 below 6 GHz frequency band. But in the whole 12~18 GHz frequency band, the dielectric constant decreases with increasing frequency, the dielectric loss angle tangent with the frequency gradually increased, increasing from 0.5 in the 12 GHz to 0.8 in the 18 GHz, which is helpful to broaden the spectrum.

2. The activated carbon permeability is very small, the real component is between 0.7 ~ 0.9, and the imaginary part is almost zero, the activated carbon is a kind of anti magnetic media, but it also has some paramagnetic.

3. On the basis of the above experiments, the paper studied the influence of different thickness on absorbing properties of activated carbon. The activated carbon thickness increases with the absorption loss increases, so the total absorption efficiency must be improved. However, due to the skin effect of electromagnetic radiation, the thickness of activated carbon is not necessary.

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