FLEXIBLE FILM WIDE RANGE ABSORBER BASED ON DIAMOND-GRAPHITE MIXTURE AND POLYETHYLENE

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In this work, we fabricated a flexible wide spectral range absorber using diamond-graphite mixture. Angular reflectivity, diffusional reflectivity and transmittance were investigated in the range 85-8000 cm^{-1} (117-1.25 µm).

Introduction

At the present time, the interactions of photon radiation with materials are actively studied [1-3]. This is due, on the one hand, to the fact that optical properties of materials are studied by using of photon radiation [4-8]. On the other hand, characteristics of photon radiation are determined using optical materials [9]. In many cases, photon radiation is used to determine reflectivity, transmittance and absorption of new materials. Wherein, reflectivity, transmittance and absorption of designed materials can be different for each wavelength range.

There are many optical high-quality materials, which are used in different applications. These materials can be optical filters, optical waveguides, mirrors, selective mirrors, photodetectors, transparent conductive electrodes, absorbers and so on. Among these materials, absorbers is unique material. This is because the high-quality absorbers have the smallest coefficient reflectivity and transmittance. Simultaneously, absorption is the largest. Ideally, a high-quality absorber should be black body where no light is transmitted or reflected. It should be noted that black body is a theoretical object that absorbs all photon radiation and is the most efficient thermal absorber and emitter [10]. In the real black body does not exist.

Since the black body efficiently converts light to heat, make the black body valuable for many applications. As an example, absorbers like black body are used in photo-thermo-electrical converters, solar energy collectors, infrared thermal detectors, emitter of radiation, narrow emitter of radiation and so on.

In this work, we fabricated a flexible wide spectral range absorber using diamond-graphite mixture. Angular reflectivity, diffusional reflectivity and transmittance were investigated in the range 85-8000 cm^{-1} (117-1.25 µm).

Experimental procedure

To produce flexible film absorber, fine diamond-graphite mixture and ultrahigh molecular polyethylene have been used. The diamond-graphite mixture was obtained by explosive synthesis. The ultrahigh molecular polyethylene was bought in Sigma-Aldrich. The diamond-graphite mixture was mixed with the ultrahigh molecular polyethylene in an agate mortar. Mass percentage for the diamond-graphite mixture and UMP was 25% and 75 %, respectively. At the manufacture of a film absorber, we tried to maximize the mass content of diamond-graphite mixture while maintaining flexible of the prepared absorber. However, above 25% of content of diamond-graphite mixture, the prepared absorber was brittle and collapses. Thus, 25% of diamond-graphite mixture was optimal mass ratio.

To study optical properties of the obtained absorber film in middle and far infrared region, we have used Bruker Vertex 80 Fourier-spectrometer (Germany) equipped with a variable angle reflection accessory A513 and diffuse reflectence accessory EasiDiff of PIKE Technologies (USA). The Bruker optical microscope Hyperion 2000 was used to view the surface of the absorber film.

Results and discussion

Fig. 1 shows a typical film absorber obtained from diamond-graphite mixture and polyethylene.

Fig. 1. A typical image of the film flexible absorber based on diamond-graphite mixture and polyethylene

To determine transmittance of the manufactured flexible film absorber, we have conducted measurement in range 85-8000 cm^{-1} (117-1.25 µm). The transmittance was 0.091 and 0.0036 at wave number of 85 and 670 cm^{-1}, respectively. In the range 400 -8000 cm^{-1}, the transmittance continues to decrease up to 6000 cm^{-1}. However, beginning with 6000 cm^{-1} the transmittance slightly increases. Generally, the transmittance of the flexible film absorber does not exceed 0.004 in this region.

We carried out measurements of diffuse reflectance in range 85-8000 cm^{-1} (117-1.25 µm). The diffusion mode of measurement was needed to collect all reflected light. Reflectance of the thin absorber was near 0.11 at 85 cm^{-1}. With an increase in the wave number up to 200 cm^{-1}, the reflectance decreased. The reflectance was already 0.048 at

200 cm^{-1}. However, with a further increase in the wave number, the reflectance was quasi-constant and did not exceed 0.06. The reflectance did not exceed 0.06 in range 400-8000 cm^{-1}. To reduce the reflectance, we made an impression on the film absorber surface. The reflectance was significantly reduced due to the impression. Beginning with 146 cm^{-1}, the reflectance does not exceed 0.02 up to 8000 cm^{-1}.

To check whether all reflected light from the film absorber was recorded by diffuse mode, we carried out measurement of angular dependence of reflectance of the film absorber in range 85-670 cm^{-1}. The main contribution to the reflectance is angles up to 20 degrees. Thus, the diffuse mode collected all the reflected light from the film absorber.

Using the measured transmittance and reflectance of the flexible film absorber in range 1000-8000 cm^{-1}, we have obtained the dependence of absorption on the wave number as shown in Fig. 2.

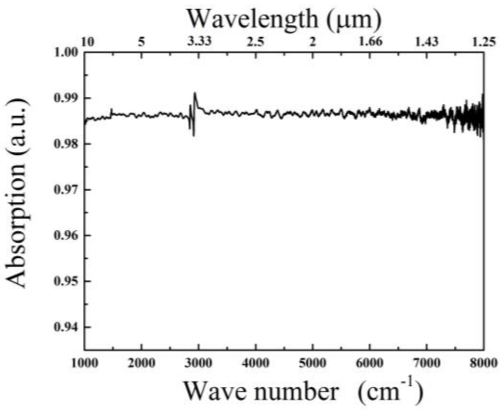

Fig. 2. The dependence of absorption of the flexible film absorber on the wave number in range 1000-8000 cm^{-1}

As can be seen from Fig. 2, the absorption practically does not change from the wave number in the range 1000-8000 cm^{-1}. Absorption is at 98.5 % Thus, we obtained a high-quality absorber.

Conclusion

In conclusion, we fabricated a flexible wide spectral range absorber using diamond-graphite mixture. Angular reflectivity, diffusional reflectivity and transmittance were investigated in the range 85–8000 cm^{-1} (117 – 1.25 μm).

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