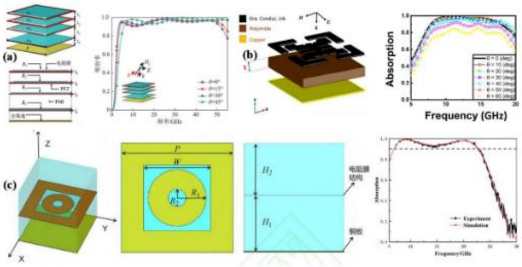

Figure 1 – relative absorption bandwidth: a – Indium tin oxide (ITO) thin film metamaterial absorber [2]; b – Graphene ink metamaterial absorber [3]; c – Conductive plastic film metamaterial absorber [5]

Since the emergence of electromagnetic absorbing materials, the research of various electromagnetic absorbing materials has made great progress, and the research and design have become increasingly mature. From the original traditional absorbing materials based on inorganic substances such as ferrite to metamaterial absorbers based on artificial resonant structures, researchers have continuously improved the performance of absorbing metamaterials through the improvement of materials and the perfection of processes. However, in terms of large-area radar stealth, there are still some shortcomings of absorbing metamaterials, such as insufficient absorption band, difficult to achieve wide incidence angles, etc. It is necessary to further improve the design of metamaterial absorbers by improving the structure of metamaterials absorbers and selecting more efficient processes, and its research prospects are still very broad.

References

1. FANG Xinrui, WANG Qian, ZHANG Qingdong, *et al*. Electronic Technology and Software Engineering[J], 2020,(06):216–218.

2. KONG Xianglin, M. A. Hongyu, CHEN Peng, *et al*. Chinese Journal of Radio Science [J], 2021, 36(6): 947–952.

3. Long L. V., Khiem N. S., Tung B. S., Tung N. T., Giang T. T., Son P. T., Khuyen B. X., Lam V. D., Chen L. Y. ，Zheng H. Y., et al. Photonics[J], 2021, 8, 440.

4. Priyanka Tiwari, Surya Kumar Pathak & V. P., *et al*. Waves in Random and ComplexMedia[J], DOI: 10.1080/17455030.2021.1972182.

5. DENG Guangsheng, CHEN Wenqing, YU Zhenchun, YANG Jun, YIN Zhiping, *et al*. Design and preparation of asymmetric broadband metamaterial absorbers based on conductive plastic films[J]. Acta Optica Sinica, 2022,42(22):2216001.

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Summary. *In this paper, a radar absorbing metamaterial structure is designed, which consists of an upper layer of resistance film and a bottom layer of metal base plate, and the middle dielectric layer is omitted. The thickness of the resistance film is 100 nm, and the thickness of the metal plate is 1mm. The calculation results of CST Microwave Studio 2021 electromagnetic simulation software show that the absorption ratio is more than 99 % in the frequency range of 2~18 GHz, and the relative bandwidth reaches 100 %.*

In the national defense and military affairs, in order to realize the long-distance camouflage of weapons, wave absorbing materials are widely used in stealth technology of aircraft, tanks, ships, etc. At the same time, broadband wave absorbing materials have significant application value in actual production, life and national defense and military affairs.

However, radar anti stealth technology and equipment have higher and higher requirements for stealth performance. Although traditional wave absorbing materials have the advantages of high permeability, high resistivity, good impedance matching performance, strong absorption loss, corrosion resistance and low cost, they have unavoidable problems such as narrow absorption band, high density and poor thermal stability, which cannot meet the requirements of current stealth technology. Wave absorbing materials are in urgent need of breakthroughs in the four aspects of "thin, light, wide and strong".

With the continuous development of metamaterials, the broadband radar absorbing materials designed and realized based on the metamaterial framework, because metamaterials are arranged by artificial "atoms", the size of artificial "atoms" is much larger than that of natural atoms, which has a more flexible electromagnetic regulation capability, which is conducive to our free regulation of its performance, so it has a larger development space in the improvement of its electromagnetic performance.

At present, the resistive film metamaterials reported in the literature are generally composed of a resistive film pattern layer on the surface, a dielectric layer in the middle and a metal backplane at the bottom. However, they all have problems such as large thickness, complex preparation, high cost and limited application scope. Through CST Microwave Studio 2021 electromagnetic simulation software, the simulated shark skin resistance film type super material absorber structure designed by our research group consists of the resistance film pattern layer on the surface and the metal backplane on the bottom. The thickness of the metamaterial is greatly reduced, and the problems such as large thickness of the metamaterial absorber and difficulty in preparation are solved. In addition, the absorption rate of more than 99 % is completely achieved in the frequency range of 2~18 GHz, and the relative bandwidth reaches 100 %.

Design idea of patterned layer of shark skin resistance film

Chinese scientists have developed a "shark skin imitation technology on the surface of the hull for boats", which is a kind of acoustic tile with the structure of shark skin imitation using bionic principles. This design enables our new submarine not only to absorb the noise generated by the submarine itself, but also to absorb and weaken the enemy's sonar detection sound wave. Acoustic wave and radar wave

As shown in fig. 1, the shark skin is composed of many uneven small scales and gullies. As the scales and gullies distributed on the shark skin form a certain volume of cavity between each other, they are connected to the outside through the small holes in the scales. This structure has obvious noise elimination effect: the external sound wave enters the cavity through the small hole, reflects many times in the cavity, rubs with the water and internal materials entering the cavity, and the sound energy is converted into heat energy. It is difficult for the sound wave to pass through the small hole to achieve noise elimination. This effect is similar to that of porous sound absorbing materials. Generally, the pore diameter of porous sound absorbing materials is concentrated between 10 um and 1mm, and the order of magnitude of shark skin scale structure is similar to it.

Inspired by this, our research team applied it to the design of metamaterial structures, taking the imitation shark skin as the pattern layer of the resistance film, and through a series of simulation experiments, data analysis, rule summary and optimization of the CST Microwave Studio 2021 electromagnetic simulation software, the optimal resistance film pattern layer model was obtained, as shown in fig. 1.

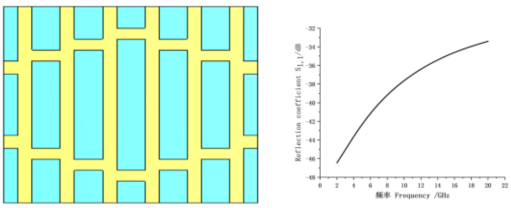

Figure 1 – Optimal resistance film pattern layer model and wave absorption performance