International Journal of New Developments in Engineering and Society
ISSN 2522-3488 Vol. 3, Issue 1: 309-314, DOI: 10.25236/IJNDES.190240

Study on Transmittance of Plastic Shed Films with Bubble Structure

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ABSTRACT. *In view of insufficient insulation of the typical plastic greenhouses in alpine regions, the study, with Numercial software, designed a plastic film with bubble structure and carried out five sets of comparative simulation experiments by changing the diameter of bubbles. The results of experiments show that in the visible light range (wavelength range from 300nm to 1100 nm), the transmittance increases with increasing wavelength, and it can be maximized when the diameter of the bubble is gradually changed. When the wavelength is less than 600 nm, the transmittance of the film is less than 60%. However, in the case of a film with a bubble structure, the transmittance of the film is significantly enhanced in the range of 300 to 600 nm, and it is also obviously improved at 600 to 1100 nm, especially at 700 to 1100 nm, it can still increase by about 10% and thereby exceeds 80%. The reflectivity is overall lower than that of the bubble-free structure, which further demonstrates that the structure proposed in this paper can further increase the utilization of solar energy from the aspects of increasing transmittance and reducing reflectivity.*

KEYWORDS: *film, Transmittance, Reflectivity*

1. Introduction

With the improvement of the living standards of urban and rural residents, the demand for vegetables overtime has increased, which has promoted the rapid development of plastic horticultural facilities based on the production of plastic greenhouse vegetables, and the size of polyethylene film market has expanded dramatically. [1-2] And the study of greenhouses plays an important role in rural areas in alpine regions, which can increase the unit yield of vegetables, promote the sustainable development of agriculture, encourage farmers to generate income, promote employment, and improve the living standards of rural residents.

The traditional agricultural greenhouse is covered with transparent plastic film on the truss to form a closed space. The temperature of the shed is raised by the radiation of the sun. In order to reduce heat loss after the night falls, the shed is covered with paper (the heat preservation capacity is generally 5~6 ° C) or quilt (the heat preservation capacity of 7 ~ 10 ° C) to preserve heat. [3] The materials covered

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on the existing greenhouses are generally outside the greenhouses. They are not only cumbersome and laborious to furl, also they are easy to be wetted by rain and snow, and the weight of the materials after soaking is 2 to 3 times that before wetting. In this case, the heat preservation capacity is reduced by 5 ° C, and the service life is also reduced a lot. In addition, the film can be seriously polluted by the covered material so that the light transmittance is easily reduced. [4-5]

The structure proposed in this paper can solve the laborious and time-consuming defects of the original scheme, it can not only remove the process of covering the quilt, but also maintain the same effect of the heat preservation. This structure requires low manufacturing cost and can be used for large-area rapid preparation and be used on sloping land.

2. Design and method of experiment

This experiment uses Numercial software to simulate and design a plastic greenhouse film with a higher transmittance and a simpler structure, which can reduce the construction cost, prolong the service life of the agricultural film and improve the shock absorption and compression resistance of the agricultural film. That is, the traditional film is filled with a certain amount of air to make it an ellipsoidal shape or an air bag column shape, and the distance between the bubble wall and the plastic outer film is defined as a track, and the change in the track distance X (um) causes a change in light transmittance. After the film is filled with air, a plurality of periodic units are tangentially extended to form a cover layer. The wall thickness of a single bubble is designed to range from 0.3 to 0.7 um. When the bubble is ellipsoidal, its inner long radius is 1-2 um and its short radius is 0.3-1.2 um, the effect is better. Further preferably, when the bubble is an ellipsoidal shape, its inner long radius is 1.3 um, its short radius is 0.7 um, the effect is better. The plastic shed film having the bubble structure is applied to an insulated plastic greenhouse.

The quality of insulation performance of plastic shed film is directly related to the growth of the plant, the most used plastic shed film is the polyethylene film. Polyethylene insulation is relatively poor. Therefore, in order to maintain the temperature inside the plastic shed, it is necessary to control the heat that escapes from the shed wall. Especially at night and in the cold winter, the insulation of the plastic shed film is more important. In most areas, the method of covering the quilt at night is adopted to keep the temperature inside the greenhouse.

In view of the fact that the insulation of the conventional polyethylene film needs to be covered by the quilt at night to achieve the heat preservation effect, the air is filled in the middle of the film to make it an ellipsoid shape as shown in Fig. 1, which effectively increases the thickness of the film. The amount of heat lost through the film when there is no air bubble is large, that is, heat is directly transferred from one side of the film to the other side. When the air is filled, the transfer medium contains the air, which can effectively block the conduction, convection and radiation of heat. Not only can the process of covering the quilt be removed, but the same warmth can be maintained.

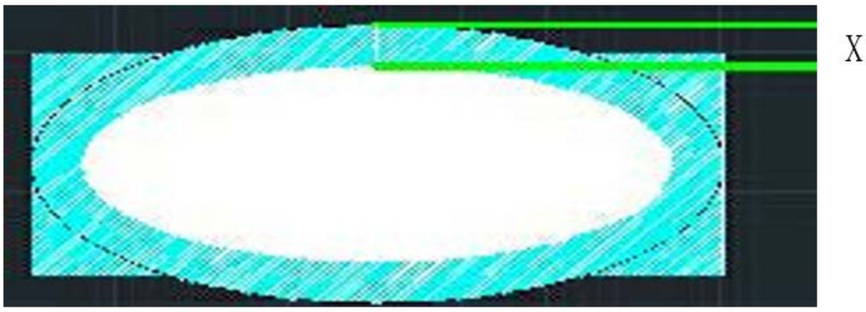

Figure. 1 Schematic diagram of a cycle

By designing the bubble with the appropriate size, when the sunlight is irradiated onto the surface of the plastic film, more light can penetrate into the film-covered greenhouse than the single-layer film, and a small part is reflected on the surface of the film and absorbed by the film itself. The transmitted light is absorbed, reflected and refracted by the surface, air, plant body, equipment, and then released and transmitted in the form of heat, so that the deep layers of the soil, the surface, the air and the plant body are kept warm, and the vegetables are grown.

3. Verification of experiment

A plastic shed film having a bubble structure, wherein the film is continuously provided with a plurality of ellipsoidal bubbles, these bubbles are tangentially extended, in which small bubbles of the same shape are arranged, the distance between small bubble walls and bubble walls is the track distance, it is 0, and the wall thickness of the bubble is 0.5 um. The bubble is an ellipsoidal shape, its inner long radius is 1.0 um, and its short radius is 0.6 um. In the small bubbles, it's air. The shed film is a polyethylene film or a polyvinyl chloride film, and the film thickness is 4 um.

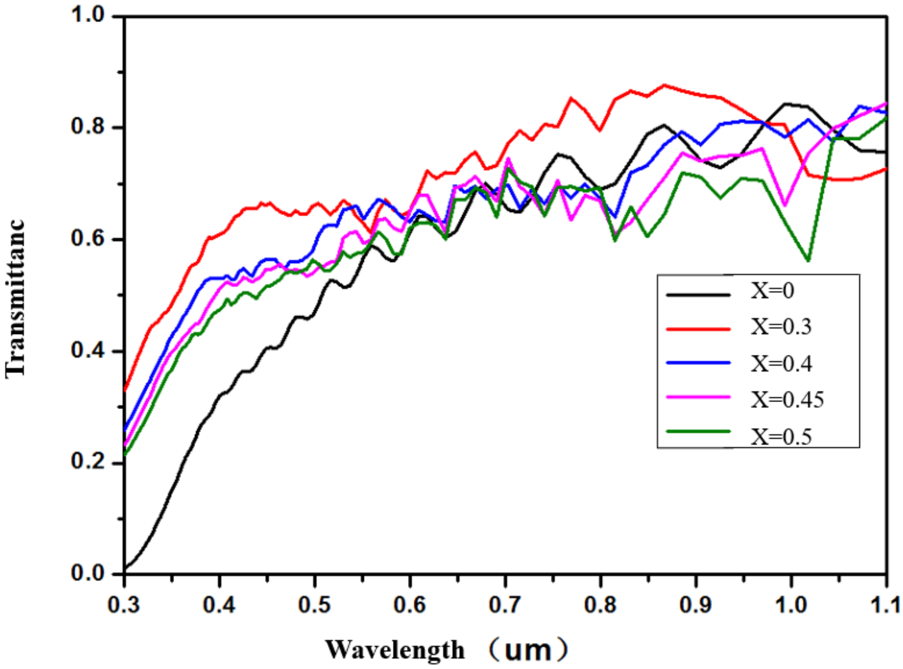

Figure. 2 transmission of the structure in the orbital X um.

In the visible light band, ie 300~1100nm, the analysis of the transmittance and emissivity of the film when there is no bubble structure is shown in fig.3 and fig. 4. That is, when X=0, the transmittance of the visible light in the 300-600 nm band increases obviously from 2% to about 50%, in the 600~1100 nm band it tends to be slow and reach 60% at about 720 nm, then it continues to increase and is always higher than 60% although some ups and downs, and in some bands it even reaches about 80%. The reflectance is less than 5% at a visible wavelength of 300 to 500 nm and it fluctuates around 5% at a wavelength of more than 500 nm, the fluctuation is relatively strong but the maximum reflectance does not exceed 10%. As shown in fig. 2.

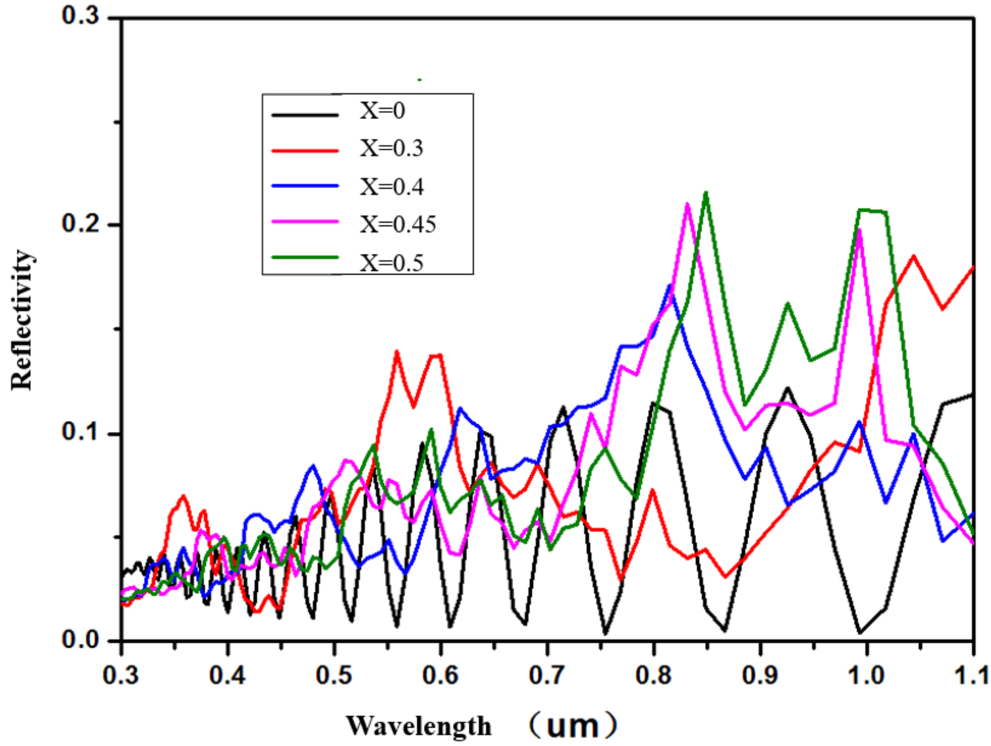

Figure. 3 Reflectance of the structure in the orbital X um

4. Conclusion

Specifically, in the view of the structural study proposed in this paper, in the case of only plastic film without other additives and structural changes, when the light of wavelength range of 300nm ~ 1100nm irradiates, from fig.2 can be seen that the transmittance increases with the increase of wavelength, however, it is less than 60% at a wavelength of less than 600 nm. However, in the case of a film with a bubble structure, the transmittance of the film is significantly enhanced in the range of 300 to 600 nm, and the increase is most significant when the orbit is 0.3 um, it reaches more than 200%, which effectively increases the light utilization and reduces the light of the band loss. There is also a significant improvement at 600~1100nm, especially at 700~1100nm, the transmittance exceeds 80% with an increase of about 10%.

In contrast, in the case of a bubble structure, as shown in FIG. 2, especially when the orbit is equal to 0.3 um, the overall reflectivity is lower than that of the bubble-free structure, which further demonstrates that the structure we have studied can further make full use of solar energy from reducing reflection to increasing transmission.

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