Stella Matutina Girls' High School (Taiwan)

APPLICATIONS OF OPTICAL REFLECTION: BUILDING MATERIALS FOR HEAT INSULATION

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With the intensification of the greenhouse effect, global warming is increasing year by year. Of the energy that sunlight provides, 53% is infrared, 45% is visible light, and 3% is UV, and nearly all the infrared radiation in sunlight is near infrared (wavelength = 750-1500nm). Because near infrared radiation provides the most energy, we hope that by measuring the reflection spectrum of common and recyclable materials in the near infrared, we will be able to find materials that have higher infrared reflectance than windows and curtains. If the materials have higher reflectance, then they will have lower sums of transmittance and absorptivity. We hope to apply them as insulation materials for building in order to lower the temperature indoors effectively and save more energy.

We conduct the experiment in two phases. During phase one, we measure the reflectance of different materials in the near infrared in the laboratory. The materials are glass, PET (hard plastic), LNDE (soft plastic), $CuSO_4$, handset surface, glass coated with correction fluid (TiO_2) and two kinds of curtains. The materials are split into two groups, the first group consists of transparent and translucent materials (glass, PET, LNDE, CuSO4, handset surface) and the second group consists of opaque materials (glass coated with correction fluid (TiO_2) and two kinds of curtains). We measure the reflectance (wavelength: 800-1600nm) by using the reflectivity system in a dark room to avoid light interference. We find that in group one, the reflectance of PET is higher than that of glass. In group two, the reflectance of glass coated with correction fluid (TiO_2) is higher than both of the curtains.

In phase two, we compare the actual insulation effect of PET with glass under sunlight. We didn't compare group two because the reflectance of glass coated with correction fluid (TiO_2) was only 0.05% higher than the curtains. We prepare two identical 30cm PET and window glass square panels that are 0.5cm thick, two thermometers, and two cardboard boxes of the same size. We make one hole on the side of each box to put the thermometers in and put the panels on top of the boxes. Then, we put the boxes under direct sunlight, time eight minutes and compare the temperatures. The average temperature of Temperature 1 is 0.94℃ lower than that of Temperature 2. Therefore, it shows that PET has better insulation properties than window glass.

In conclusion, PET may be used as a low-cost and recyclable substitute for window glass or window tinting films to save energy and resources in the future.

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GREEN POWERED GRAVITY LIGHT

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Our study, Green Powered Gravity Light, was inspired by two British designers, Jim Reeves and Martin Reddiford. They developed Gravity Light for the purpose of solving the problem of power shortages. Its power generation principle is transforming gravity into electricity. After doing some researches on the device, we came up with an innovative idea of using recycled materials to build an eco-friendly Gravity Light.

In order to make our power generation more efficient, we replaced the previous handmade generator by a modified ceiling fan motor which can output 20 volts at the speed of 96PRM. However, the weight fell too fast. Therefore, we added one more pair of wheel and axle to slow down the weight.

As the new generator works, we tested the relationship between the kilograms of the weight, the falling time and voltage. We found out that when the weight increases 1 kilogram, the falling time will decrease, and the average voltage will increase 5 volts meantime.

Although we couldn't test the generating efficiency directly, with kinetic energy transferring efficiency, we found that the heavier the weight is, the more energy generating efficiency can the gravity light produce. When the weight is 11 kilograms, the gravity light can produce the best kinetic energy transferring efficiency, which is 77%. If it is over 11 kilograms, the kinetic energy transferring efficiency will still maintain at 77%.

In conclusion, although our gravity light's generation efficiency isn't as high as the ready-made ones, it proves that recycled materials can be utilized in real life. Second, when under 11 kilograms, the heavier the weight is, the shorter time it shines, and the more efficient it is. Last, when the weight is 8 kg, our gravity light is in the best condition. The reason why we chose 8 kg is that it can make the LEDs' brightness high enough, and it is relatively easy to lift. It can fall for 213.9 seconds and produce 12 volts.

In the future, we would like to improve our device in three ways below. First, we have already come up with an idea to hang our Gravity Light on the wall. This way, we could shrink its volume and create longer time for the LEDs to illuminate. Second, we would add battery in the circuit. This way, we can hang heavier weights to improve the generating efficiency and expand the LEDs' illuminating time.