Strontium aluminate based non-electric light module for roof installation.

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Solution Overview

The proposed solution is based on the use of strontium aluminates as a light source for night lighting of toilets.

The concept is based on a transparent (structured) ceiling module that has large surfaces coated from the inside with strontium aluminate. Strontium aluminate is a long-lasting photoluminescent pigment. The transparent roof module is charged during the day by the solar UV radiation. At night, it releases the energy stored in the material in the form of visible light (in the green to blue spectrum).

This solution is deliberately designed for permanent installation and does not require any electrical systems. By eliminating electrical components such as solar modules that are removed for charging cell phones, for example, a proprietary solution is created that is less attractive to theft. At the same time, this approach provides an extremely low maintenance solution that is very easy to install.

The solution is based on low-cost thermoformed PET-G/PET elements and photoluminescent pigments. This process is widely used in the packaging industry and for the production of PSA equipment, ensuring cost-optimized and flexible production. The process is relatively low-complexity so that local production is also conceivable. The installation is done with simple tools as a retrofit for existing sheet metal roofs.

Detailed description of proposed solution

The structure consists of two layers of stable 1,5-3mm thick thermoformed PET-G or PET film forming several cavities which are filled with strontium aluminate pigments or

coated with strontium aluminate based paint. These elements are ultrasonically or thermally welded together to create a hermetic cavity that protects the contained photoluminescent pigment from environmental effects.

A structuring of the transparent surface provides on the one hand for an additional view protection while during the day a better illumination of the toilet by sunlight is achieved. At the same time, this structure also stabilizes the material to make the surface even more robust.

The material used is resistant to environmental influences such as water, UV radiation and sand. As the material has a high elastic deformation, it is not susceptible to breakage and is used for example for bicycle helmets or industrial and medical PPE equipment.

Strontium aluminate is a non-toxic, non-flammable and non-radioactive photoluminescent substance. It can be charged by naturally occurring uv radiation from the sun. In this way, a maximum luminous period of up to 24 hours can be achieved, which gradually decreases. The proposed PET-G/PET material, unlike float glass, is transparent to the relevant UV spectra, allowing charging through the material.

For installation, part of the sheet metal roof is removed (e.g. with an angle grinder, jigsaw or saber saw) and replaced by the new, transparent light element. The new element is placed on the front of the roof and has an overlap that ensures the continuation of the tightness of the roof.

Preferably riveted (pop rivets) connections should be used for assembly. These are simple and can be installed with inexpensive tools without special prior knowledge. At the same time, they make the undamaged removal of the element more difficult and time-consuming, thus creating an additional hurdle against theft.

Please share how the proposed solution meets stated Requirements and Acceptance Criteria.

The proposed solution can emit light up to 24 hours after charging by the sun. This far exceeds the 12 hours of darkness expected in the equatorial regions of the subtropics and tropics.

The proposed solution requires only mechanical but no electrical installation. Thus, it can be installed by simple manual skills. The system is low-maintenance, so at most superficial cleaning may be required at longer intervals.

The system is based entirely on solar radiation. The PET-G/PET material used can come from recycled sources to improve the carbon footprint of the product. PET is widely used as a recycled material and is available in high quality, which is also used for food packaging.

The roof module can be permanently attached to the roof, making theft difficult. At the same time, it has been deliberately designed for target application, making it less attractive for theft.

PET-G & PET, which form the basis for the proposed module, have extremely robust properties. The material is waterproof and, unlike other plastics such as PLA or nylon, absorbs virtually no water from the ambient air. At the same time it is chemically very stable and heat resistant. Due to the thickness and shape of the material, very stable structures can be created, which can withstand even strong weather phenomena without any problems.

The product can be installed by riveting, gluing or screwing, regardless of the existing roof. The mold construction for thermoforming is relatively inexpensive compared to injection molding, which means that several mold variants are conceivable. For small runs, less expensive prototype molds can be produced or 3D-printed rapid prototyping models can be used. The material can be 3D printed, which means that the shape can be evaluated in the final material before the tool is made.

Especially in medium and large runs, the proposed forming process can be very economical. The molded parts could be produced for less than 1-2$ at appropriate quantities. Strontium aluminates are available even to end users in very small quantities for under $60 per kg. At typical concentrations of 10-20% pigment per liter of paint, this corresponds to a pigment cost of $6-12 per liter of paint.

Even with extremely conservative estimates of <100ml/color per element, this equates to just $0.6-1.2 in pigment costs per module. With wholesale purchases, these costs could be reduced considerably.

The target colors are green to blue, as these provide the longest luminous period and highest light output. The same pigment could also be used as a sticker, sign, paint or similar to make individual areas of the toilet more visible. (e.g. door handles, door markings men/women toilet, locking mechanisms etc.)

What area of the latrine does this solution apply to?
Lighting

How does the solution impact lighting, locking, alerting or other innovative improvement or integration propositions?
The solution offers a very cost effective and easy to implement lighting system that provides sufficient light for safe use of the toilets. At the same time, it is technically low-complex and robust so that it can be implemented more reliably than electrical solutions. In addition, it also improves daytime use, as its UV transmittance kills bacteria and viruses that can be found on the door handle inside, for example.

What is the estimated cost for this solution?
The expected cost per piece should be easily brought below $10 per large finished lighting module, even for smaller runs. For larger runs it is conceivable that a large module can be realized for under 5$. The size of the module directly controls the available illumination intensity due to the photoluminescent surface. If the cost pressure is very high, this could be reduced in favor of a lower production price, but this would result in a less optimal lighting situation.

The installation should be possible in less than 30 minutes without special training. A set of tools for an installer (e.g., cordless angle grinder, safety glasses, ear protection, riveting pliers, drill press, and rivets) should be available for $100-200, although these tools could also be useful for other work at the camp or provided on a rental basis for installation. Tooling costs vary depending on the selected process and the target conditions. For high-end thermoforming tools, this should be a maximum of $10,000, while simpler tools can be realized for $1,000 or less.

How can this be retrofitted to existing latrines? If it can't, please state your use case.
For the installation only a part of the roof is removed. The module is placed and permanently connected to the existing roof. For the riveting, only a few holes need to be drilled and some rivets have to be fastened.

How will this solution be maintained?
The system is extremely low maintenance as it is not based on electrical processes. The only maintenance required is cleaning at longer intervals. For example, if a sandstorm occurs and sand is deposited on the module, it can be cleaned by brushing it off or pouring water over it. No other maintenance tasks are expected.

Please share the innovative highlights of your proposed solution.
The proposed solution is extremely optimized on three factors:
Simplicity, Durability & Reliability.

The combination of thermoformed plastic and strontium aluminate meets these criteria much better than a more expensive, fragile and complex conventional electrical approach with solar panels, power storage and light sources. All these single elements can lead to a total failure of the system.

Proprietary alignment prevents theft, which is common with solar modules. The installation is simple and robust.

The light provides a pleasant user experience. It provides good visibility without being overly bright. In the early evening it shines a little brighter, while as the night progresses it dims down a little on its own, but is still powerful enough for good use in the dark.

Are you interested in potential further collaboration?
Yes

ATTACHMENTS