Form 8

Research Result Report
ICRR Inter-University Research Program 2023

Research Subject:

Research and Development of the high-performance segment mirrors and the camera entrance windows for the CTA Large Size Telescopes

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Summary of Research Result :

Introduction: We designed LSTs not only with large reflectors but also with highly reflective mirrors, UV transparent camera entrance windows, high Q.E. and high-speed photosensors, and high bandwidth readout electronics to achieve lower energy thresholds. Thanks to the low energy threshold, the CTA-LSTs extend the gamma-ray observation horizon to the redshift z = 4 and empower observational studies of high redshift AGNs and bursting sources Gamma-Ray bursts. In addition, CTA assumes a long-term operation period of about 20 to 30 years, and all telescope elements must maintain stable performance over a long period.

We understand that the degradation rate of mirror reflectivity is less than 1%/yr from the intensity of the muon Cherenkov light of LST1. We propose a new longer-life mirror surface coating with a deterioration rate of 0.5%/yr or less, suppresses average deterioration to 10% or less over 20 years of operation, and reduces the frequency of mirror replacements.

In addition, an anti-reflection coating is applied to the UV transmissive plastic dome installed on the camera entrance windows to increase the transmittance to over 98%. After investigation, we would like to provide an antistatic coating to minimize the adhesion of dust. Based on experience, the reflectance effect of dust is about 5% at maximum on mirrors and entrance domes.

The mechanical structure of the mirrors supplied to LST1-4 consists of 2.7mm of glass + 50mm of Al Honeycomb + 2.7mm of glass. The five layers of coating on the glass surface, SiO2 + HfO2 + SiO2 + Al + Cr, are produced by sputtering. We obtained 92% reflectance on average with this method.

Some research results: The seven layers of coating, SiO2 + HfO2 + SiO2 + HfO2 + SiO2 + Al + Cr, are on the glass surface by the sputtering method will enhance the reflectivity and minimize the aging effect. Ten years ago, we tested these seven coating layers and got an excellent result. We can also control the spectral response of the reflectivity to fit better with future SiPM cameras.

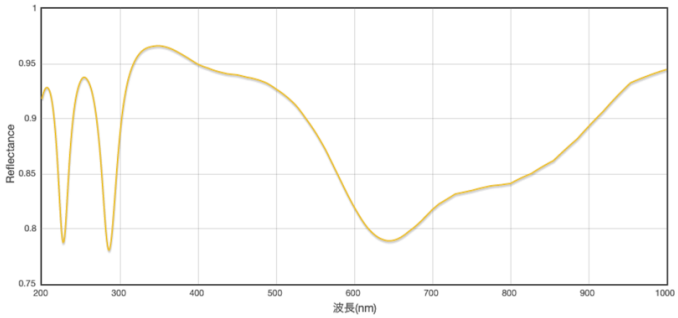

Figure 1. The promising reflectance of seven layers with coating improves the peak reflectance to 97% with optics simulation. We estimate the lifetime becomes longer than five layers of coating. The first trial in 2023 did not achieve such improvement, but we will continue the effort.

For the entrance window we found the coating material which reduce the dust attachment on the surface of the camera entrance window. Unfortunately it does not improve optical transmission but keep the surface clean from dusts.

No.