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POMATA

preventing environmental aging factors on Cherenkov mirror coatings with protective oils

Iovenitti S.[*,a], Crestan S.[f], Leto G.[c], Gibertini E.[e],
Basso S.[a], Bianco A.[a, e], Bonnoli G.[a], Civitani M.[a], Lessio G.[b], Pareschi G.[a], Sironi G.[a], Valsecchi G.[d], Vecchi G.[a]

[a] INAF - Osservatorio astronomico di Brera, via Emilio Bianchi 46, Merate (LC) 23807 - IT.
[b] INAF - Osservatorio astronomico di Padova, Vicolo Osservatorio 5, Padova (PD) 35122 - IT.
[c] INAF - Osservatorio astrofisico di Catania, Via Santa Sofia 78, Catania (CT) 95123 - IT.
[d] Media Lario Srl, Via al Pascolo 10, Bosisio Parini (LC) 23842 - IT.
[e] Politecnico di Milano, DCMC "Giulio Natta", P.za L. da Vinci 32, Milano (MI) 20133 - IT.
[f] INAF - IASF, Via Alfonso Corti 12, Milano (MI) 20133 - IT.

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INTRODUCTION

POMATA (Protective Oils for Mirrors Aging on Telescopes Alfresco) is a project funded by the Italian National Institute for Astrophysics (INAF) aimed at identifying an adequate protective overcoating layer for mirrors of Cherenkov telescopes. Unlike traditional observatories with domes, such instruments lack protective enclosures *[1]*, exposing their mirrors to a range of detrimental elements, including atmospheric agents, thermal shocks, chemical reactions, and abrasive particles (fig. 1).

Fig. 1: The prototype telescope ASTRI-Horn *[2]*, on Mount Etna. It is an example of Imaging Atmospheric Cherenkov Telescope *[3]* and its mirrors suffer from fast degradation due to gases and dust released during eruptions of volcano.

Usually, on top of the mirrors' reflecting layer a protective nanometric coating transparent in the UV band (e.g., SiO2) is deposited under vacuum *[4]*.

Micro-damages in the coating and dirt accumulation may reduce the effective area and degrade the performance of the instrument *[5]*, so **an additional over-coating is desirable**.

We conducted a **comparative study** focusing on *silicon oils*, synthetic polymers with suitable properties. We requested that the **application method** be simple and economical: deposition in air using a spray can and a cloth to uniform the layer.

Fig. 2: Experimental setup for reflectivity measurements in lab.

THE EXPERIMENT

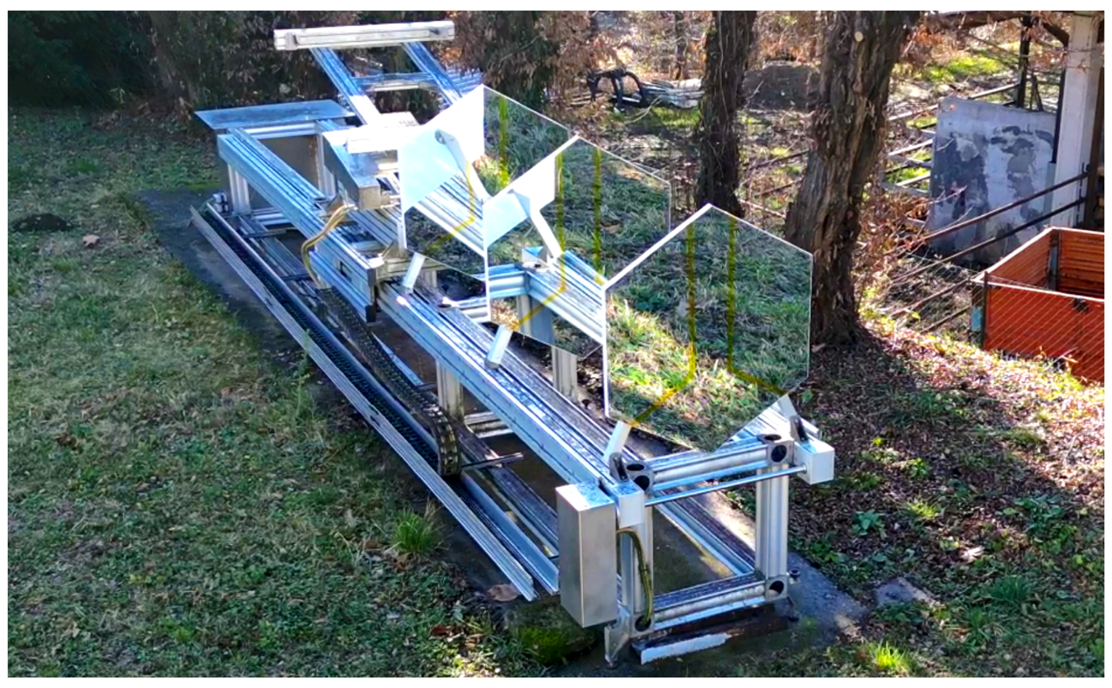

Fig. 3: Mirrors aging alfresco, on a pre-existing facility (INAF-OAB, Merate, Italy).

After a preliminary phase, we selected 4 commercial silicon oils: 1. Nasiol C *[6]*; 2. Nanobiotech Vitro Plus *[7]*; 3. Wacker AK 0,65 *[8]*; 4. Wacker Helisol 10A *[9]*.

We applied them on 2+1 spare mirrors provided by the ASTRI project (03, 07, and 63). We monitored two quantities:

- the **reflectivity curve**, in the range 300-550 nm, using a Filmetrics F20-UVX *[10]* spectral analyzer;
- the **area loss,** i.e. the percentage of non-reflecting surface, using a Sony Alpha mirrorless camera *[11]*.

Data were taken at three different times: at mirror delivery (t_0), after the oil application (t_1) and after 6 months at open-air (t_2).

To sample the mirror uniformly we used a paper mask with the pattern of figure 4. Each mirror has three areas, two treated with oils (A and B), one left untreated as a control arm (C).

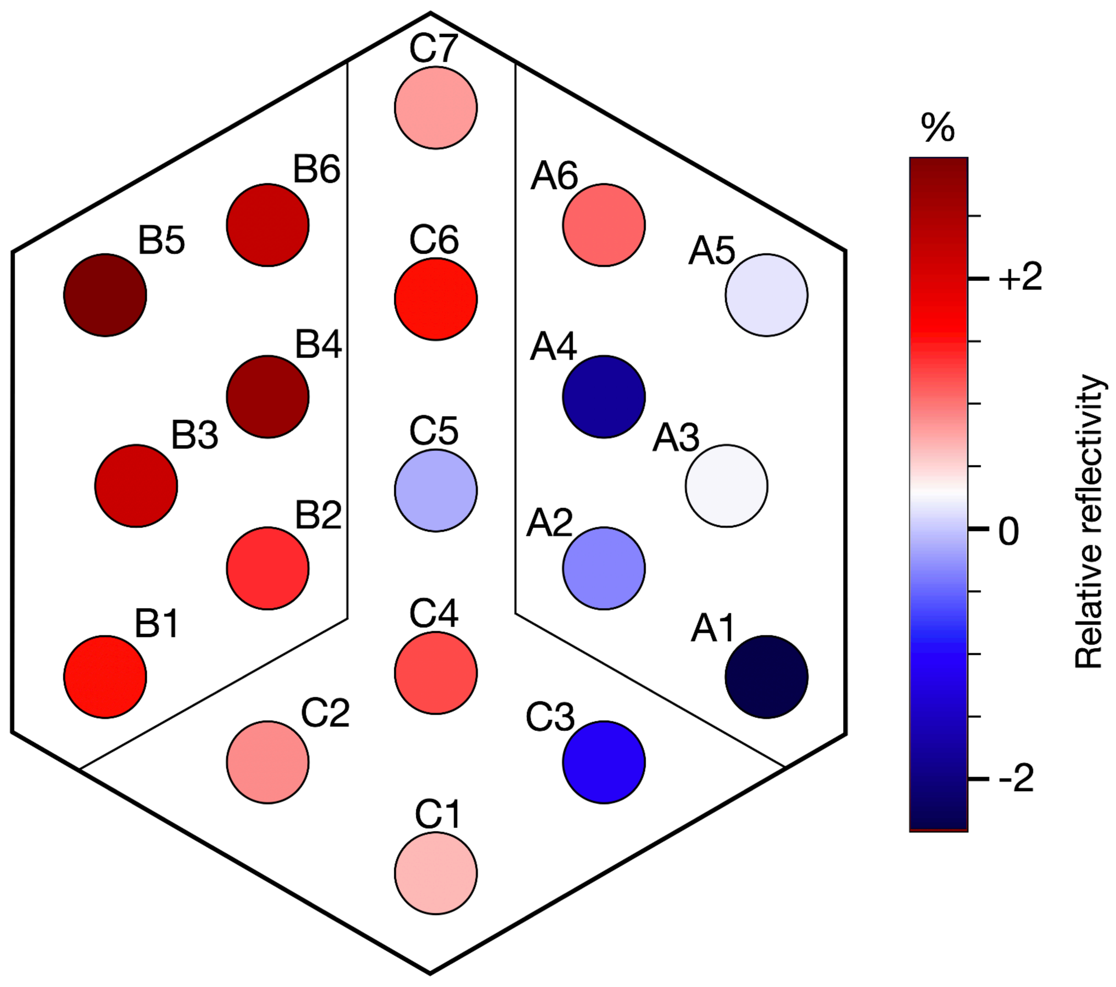

Fig. 4: Relative reflectivity at t_2 for mirror 07 with refer to the average degradation of the control arm (C, 4.3%). Area B is Oil-3, area A is Oil-2.

RESULTS

Reflectivity curve. The control arm allowed us to monitor the *natural degradation* of mirrors. Figure 4 shows the excess of reflectivity (integrated) with respect to the control arm at t_2: Oil-3 is on average 1.8% better. Considering the frequency curve (fig. 5, *right*), Oil-3 is again the only one above the control arm (~3σ) all over the bandwidth (fig. 5, *left*).

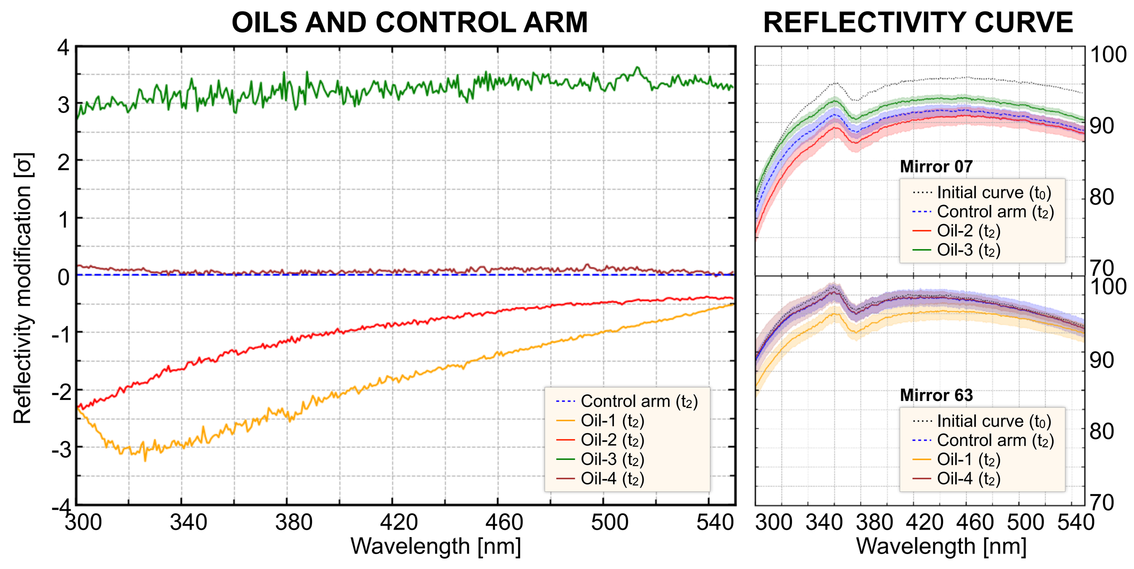

Fig. 5: Measured reflectivity curves (*right*) and their difference with the control arm (*left*) in terms of σ (standard deviation of measures).

Area loss. For the control region the area loss due to dirt, scratches and dust on the mirror is 1.5%. With Oil-3 this values improve slightly, while other products do not help the self-cleaning (fig. 6).

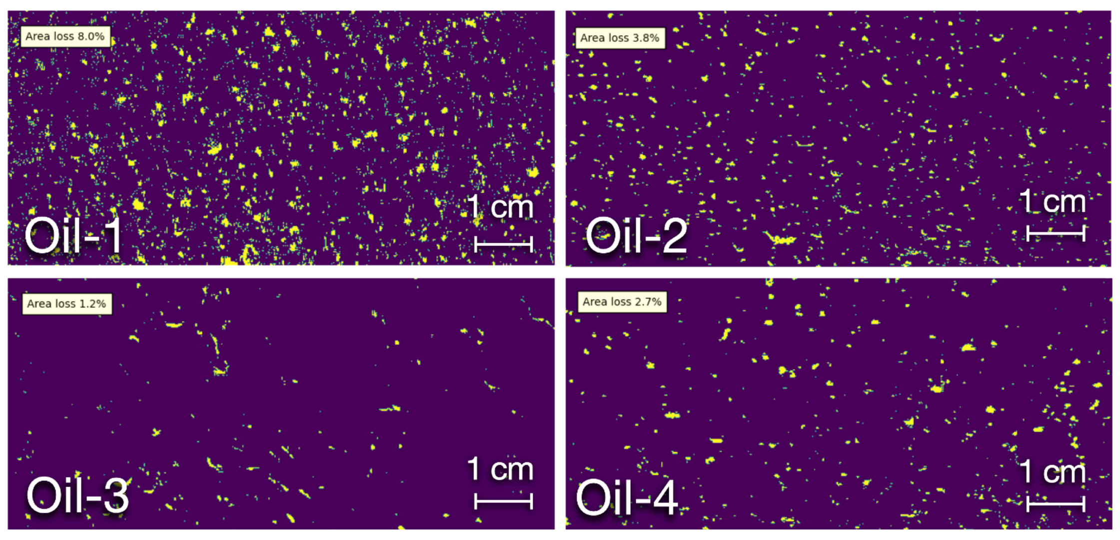

Fig. 6: Dirt and dust in regions with different oils producing *area loss.*

CONCLUSIONS

Oil-3 seems to mitigate the degradation of mirrors in the Cherenkov wavelength range, both in terms of area loss and reflectivity curve. This preliminary result needs to be confirmed with larger statistics and longer periods, in light of the possible application of the oil to hundreds of instruments. So far, we have demonstrated that our method for data taking, calibration and reduction, is sensitive and effective for comparative purposes.

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* email contact: pomata.oabr@inaf.it