Space Renaissance Italia

a chapter of Space Renaissance International

Title: **Innovative Optical Materials for the developments of Diffractive and Holographic Devices**

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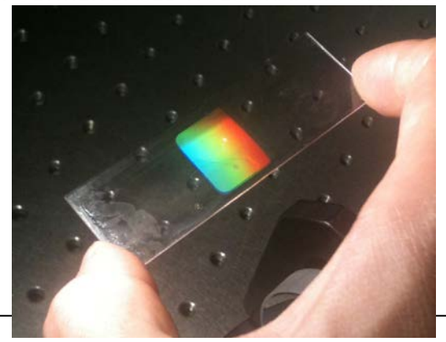
Abstract
This paper describes the experimental research on innovative polymeric materials for the realization of holographic optical elements.
The space technologies applied in the development of scientific payload as used in the analysis of the atmosphere composition for Planetary observation applications, have been used to realize highly efficient diffractive devices for integration in low cost and compact instrumentation, for terrestrial application as well.

Space exploration technologies involved in the project
The Antares Scarl's study (see Participants) involves the technological know-how achieved by CGS SpA in its research activities on holographic optical elements for Space Exploration application. Diffractive optical elements, based on polymeric materials, have been developed for the realization of compact spectroscopic payloads, such as multispectral and hyperspectral cameras, for the analysis of chemical composition of planets atmosphere.

POLYMER BASED HOLOGRAPHIC GRATING

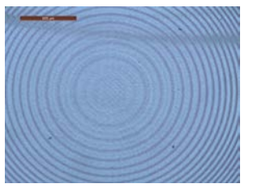


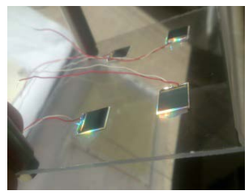
Description of the project and its benefits for the citizens
The main goal of the Antares Scarl's activities is the study of photosensitive polymeric materials to be used in the development of diffractive gratings. These devices can be used as dispersive optical elements for spectroscopic analysis of chemical composition of liquid or gaseous species.
The main advantages of this technique are the very high diffraction efficiency, compared to the standard diffraction gratings, the reproducibility of the optical characteristics and the low cost. These performances allow to produce compact spectrometers that can be used for a wide range of civil applications, such as: food and beverage quality analysis; environmental monitoring; homeland security; drugs detection (law enforcement) and anti-adulteration.
The ability of light manipulation shown by these diffractive devices, has been exploited by Antares, even in the development of holographic solar concentrators for high efficiency and low cost photovoltaic modules.
The use of polymer based diffractive elements allows to realize planar optical concentrators with high performance, comparable to standard ones. Moreover, the technological processes and the materials involved, results in less-expensive devices compared to the standard approaches, such as micro-machined Fresnel lens or spherical mirror. The devices performances previously described allow the diffusion of medium and low scale solar power plants on the EU area, with more benefits for the European citizens.

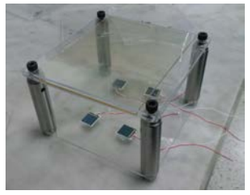
Status of the activity and future developments
To date, Antares' activity is in pre-industrialization phase. The optical and thermal properties of the materials were analyzed. Numerical modeling of holographic optical elements based on polymer has been performed and the production process for holographic optical element is in the process of realization.
Volume holograms were recorded in polymer substrates.
The experimental results on the diffractive properties, in terms of dispersion, efficiency and spectral bandwidth, are available.
The prototype of the volume holographic grating spectrometer is available, while the solar concentrator based on holographic lens is under development.
Technological updating of optical materials and devices can be primarily related to holographic solar concentrators.
To date, a promising approach is represented by hybrid solar cells composed of Si/SiC cells with polymer-based volume holograms.

Enhancements related to space exploration technologies
Both technological approaches can be used to enhance the performances of planetary Rovers and Space Probes, for space exploration applications.
High efficiency photovoltaic modules can reduce the complexity of power system design, the volume and development costs, with high benefit in terms of mission cost and life cycle.
On the other side, transmission gratings with high diffraction efficiency, allow the development of spectroscopic instrument with simple architectures, reducing size and cost of the payloads.
This allow to increase the number of scientific experiments to be boarded on the same planetary probe.

HOLOGRAPHIC SOLAR CONCENTRATOR







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