Gaia’s mirrors

The European satellite Gaia is set to chart our sky with unprecedented precision: a technological prowess achieved with the help of its two primary mirrors in silicon carbide, polished by Reosc, a Sagem (Safran) subsidiary and space optics industry leader.

The European Space Agency (ESA) has entrusted Gaia with the ambitious mission of creating a three-dimensional map of a billion stars. This astrometrical data is vital to every field of study of our universe: the more precise and abundant the data, the better the ensuing analyses. Gaia was launched on December 19, 2013, and reached its operational orbit on January 8. It was designed to achieve a precision of 1/100,000th of an arc second. “The satellite is 100 times more precise in defining stars' position than its predecessor, Hipparcos, which was launched in 1989,” said Roland Geyl, head of sales and marketing at Reosc, Sagem's specialized high-performance optics subsidiary. “Gaia is equipped with two telescopes, which will simultaneously observe two stars forming a 106° angle. As it revolves, it will trace out a long triangulation and progressively piece together an extremely precise, three-dimensional map of the sky.”

Ultra high-definition polishing

Astrium, which was chosen by ESA to design and produce the satellite, tasked its long-standing partner Reosc with polishing the telescope's two primary mirrors. "They are made of silicon carbide, which is a world first for us," explained Roland Geyl. "This black ceramic material dilates very little. It has excellent mechanical and thermal performances. However its extreme hardness makes it particularly difficult to polish." And yet this is a vital operation, since the telescope's precision depends on it. "Astrium sends us the "unfinished" parts, which have a roughness of around 20 microns, and it is our job to grind them, polish them and refine them down to within 10 nanometers of the desired result. In other words, the part is polished to a thousand times finer than in the beginning!" To achieve this, Reosc uses fine diamond powder and works the optical surfaces with computer-aided polishing robots. "We simply cannot afford to make mistakes: the slightest error can cost us three or four months’ work. It's essential to have a thorough command of production and measurement processes," said Roland Geyl. In the end, it took nearly a year and a half to polish the two 150 cm long by 60 cm wide concave mirrors.

Reflectivity: the finishing touch

Once polished, the mirror is still not finished. A silver-based reflective layer has to be placed on the base structure to provide reflectivity. This world-first operation is performed by evaporation in a vacuum and condensation on the surface. "By successfully combining this first layer with a quartz-based protective coating, we can even enhance the mirror's performance," added Roland Geyl in conclusion. This achievement further reinforces Reosc's leadership in space optics and should open up new business prospects for the company in both space and defense.

* Astrometry is the branch of astronomy that measures the position, distance and movement of stars and other celestial objects. It gives astronomers a frame of reference for their observations and is used to establish Universal Time.
** Unit of measurement for angles. Gaia is so precise that a person on earth could use it to read a book situated on the moon.