PRESS INFORMATION

No. 001/2020

Date: January 28, 2020

Location: Mainz, Germany

Milestone: Tertiary mirror substrate for the ELT delivered

SCHOTT produces substrates for four of the five mirrors of the ESO telescope / Series production for the giant mirror to start in the spring

The SCHOTT technology group is manufacturing the material for a total of four out of five mirrors for the precise view into space that will be provided by the Extremely Large Telescope (ELT) at ESO (European Southern Observatory). It is considered to be the world's most powerful telescope in the future. After components for the segmented fourth mirror (M4) had already been delivered in 2016 and the world's largest convex 4.2 m secondary mirror (M2) in 2019, the tertiary mirror substrate (M3) has now left the SCHOTT headquarters in Mainz. The glass-ceramic substrate, which measures four meters in diameter, is ten centimeters thick and weighs 3.2 tons. It will be finely polished by the French company Safran Reosc for several months before it begins its journey to Chile on top of the Cerro Armazones that is over 3,000 meters high. The ELT is scheduled to have its "First Light" in 2025. Astronomers want to use the giant telescope (total value EUR 1.1 billion) to track down exoplanets outside our solar system, gain detailed knowledge of stars and galaxies in the still young universe and unravel the mystery of dark energy.

Producing a mirror substrate the size of the concave M3 and 4 meters in diameter requires not only expertise and great care but above all one thing: time. The ELT team at SCHOTT needed around 15 months to complete the diverse and extremely demanding process steps. To manufacture the material, high-quality raw materials such as silicon, aluminum and lithium first need to be melted at temperatures of around 1,350 degrees Celsius. Afterwards, the hot glass mass is cooled down in a controlled manner under cooling hoods. The glass is then converted into glass-ceramic in subsequent heat treatment and repeat cooling. During this process, crystals whose size can be specifically adjusted are created. The size and number of crystallites as well as the correct ratio of residual glass phase (about 30 percent) and crystal phase (about 70 percent) combine to create the most important unique selling point of ZERODUR® glass-ceramic: an extremely low coefficient of thermal expansion as the measure of the change in length when the temperature rises. But what does this mean? For the ELT's M2, which measures approximately 14 square meters, with a temperature change of one degree Celsius, this allows a maximum shape deviation of two nanometers. Translated to the area of the city of Mainz with 100 square kilometers, this is 14 millimeters.

At a state-of-the-art 5-axis CNC machining center, the tertiary mirror substrate was ground down to its final weight of 3,200 kilograms by performing several machining steps. The lower the weight, the less complex the telescope mechanics have to be. The back of the mirror material was etched with hydrofluoric acid to remove micro-cracks that occur during grinding. A perfect material surface is important to ensure an optimal bonding of the mirror underside with pads or actuators that fix and align the mirror precisely. The tertiary mirror is located in the telescope optics below the huge primary mirror. The light from it first hits the convex M2 that is mounted about 30 meters above, before it hits the M3 through the center hole in the M4.

Following the delivery of the 4 m tertiary mirror substrate, SCHOTT will begin with series production of the 1.52 m substrate elements for the segments of the 39 m primary mirror in spring 2020. SCHOTT will supply a total of 931 parts for this by 2024. The mirror substrate components – 798 for the primary mirror plus 133 spare parts – will also be processed at Safran Reosc, i.e. polished and cut into hexagons.

In numerous superlative telescope projects – like the ESO Very Large Telescope (VLT), the Gran Telescopio Canarias (GTC), the Keck Telescopes on Hawaii, the DKIST solar telescope or the flying NASA telescope Sofia – the glass-ceramic ZERODUR® has been the gold standard for mirror substrates for decades due to its thermal expansion coefficient close to zero. The material was developed by SCHOTT in Mainz more than 50 years ago. It enables extreme shape accuracy and ensures sharp images from space. The telescope instruments break down the light from the collected celestial objects into spectral colors: Thanks to the huge and extremely precise light-collecting surface of the ELT main mirror, it will be possible to analyse much lower light intensity objects in the future than currently available.

Links: SCHOTT goes ELT

Photos:

SCHOTT is supplying high-precision mirror components for four out of the five mirrors of the Extremely Large Telescope (ELT). This picture shows the technical acceptance of the 4 m-

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ZERODUR® tertiary mirror substrate (M3) by representatives of the European Southern Observatory ESO. Photo: SCHOTT

The 4 m mirror substrate is lifted by a suction lifter so that it can be further processed on the CNC processing machine. When it is delivered, the M3 is only 10 centimeters thick and weighs 3,200 kilograms. Photo: SCHOTT

Bye-bye M3! The tertiary mirror substrate (M3) for the ELT leaves the SCHOTT main plant in Mainz and starts its journey to France, where the 3.2-ton glass-ceramic blank is finely polished. Photo: SCHOTT

SCHOTT is a leading international technology group in the areas of specialty glass, glass-ceramics and related high-tech materials. With over 130 years of experience, the company is an innovative partner to many industries, including the home appliance, pharma, electronics, optics, life sciences, automotive and aviation industries. SCHOTT has a global presence with production sites and sales offices in 34 countries. In the 2018/2019 fiscal year, the group generated sales of EUR 2.2 billion with over 16,200 employees. SCHOTT AG has its headquarters in Mainz (Germany) and is solely owned by the Carl Zeiss Foundation. This is one of the oldest private and largest science-promoting foundations in Germany. As a foundation company, SCHOTT assumes special responsibility for its employees, society and the environment.

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