Training Opportunity for Belgian Trainees

Reference	Title	Duty Station
BE-2021-TEC-QEE	**Environmental testing simulation and contamination effects studies on space materials and assemblies via laser technology**	**ESTEC**

Overview of the mission:

The Materials' Physics & Chemistry Section, with a team of about 30 people, provides quality and engineering support to all ESA projects and development programmes, and operates state-of-the-art space simulation facilities and instrumentation to characterise materials for space missions.

More specifically we perform:
- physical and chemical analysis and characterisation of materials and related processes (phase transitions, thermo-mechanical analysis, thermo-optical analysis, surface analyses, all types of spectroscopy, non-destructive techniques);
- cleanliness and contamination control (end-to-end: from requirements definition to their final verification);
- environmental evaluation (ground and space effects simulated in a great variety of combinations);
- performance prediction and verification of materials (and associated processes) suitability for specific mission objectives.

Overview of the field of activity proposed:

Space is an exceptionally harsh environment. Severe conditions include sun and deep space radiation, hazardous space debris, extreme temperature changes, etc. Furthermore, due to vacuum conditions under space, molecular contamination due to outgassing from organic materials can be a source of significant degradation for space equipment, especially for sensitive optical instruments. As a result of this environment, the performance of space hardware can be drastically degraded, resulting in a reduction of functionality or even hardware failure. The ability to adequately test and predict materials behavior under various space environment conditions is therefore of utmost importance.

High Power Laser technology is among those of very high interest that can be used to simulate the effects of the space environment using ground based test facilities. For example, the Section currently uses a high power CO2 laser in its atomic oxygen simulator. Moreover, the activities performed during the development of ESA's Aeolus/ALADIN laser instrument showed that laser induced contamination deposits can be formed on optical surfaces in vacuum, even for trace amounts of contamination. It was shown that the deposit formation was often accompanied by other measureable effects associated with the laser irradiated surfaces, such as alteration of the properties of the transmitted/reflected laser beam (absorption, wavefront distortion, scattering etc) and by emission of laser induced fluorescence. This was the case even for very thin (several nanometre) deposits. This raises the question if accurate measurement of laser beam effects can be used as a diagnostic tool to detect and quantify very thin contamination layers on surfaces in vacuum.

The overall aim of the project is to investigate advanced laser and optical techniques which can be used to simulate space environmental effects on materials and assemblies.
Several areas of interest have been identified :

- ultra-sensitive laser-based contamination detection (as new capability and in support to upcoming missions such as LISA and - hopefully - Aeolus II)

- simulation of UV induced degradation of optical adhesives using laser radiation
- space debris particle acceleration using laser-driven flyer plates

The work plan will consist of :

- state of the art literature review of relevant laser based techniques;
- definition of experimental test plan;
- help to design and commission new test facilities, working with other engineers in the Section;
- implement an experimental test programme using representative materials and assemblies for future ESA missions or technology development activities.

This will be predominantly an experimental based project but there will also be the opportunity for theoretical studies. Experience working with lasers and optical systems would be useful but not essential as the relevant training will be provided.

Required education and skills:

- Master's degree in a technical or scientific discipline
- Good interpersonal and communication skills
- Ability to work in a multi-cultural environment, both independently and as part of a team
- Fluency in English and/or French, the working languages of the Agency