Contribution prepared for ISMSE15

Multifunctional adhesives through nano-enabling for use in space

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Adhesives have been extensively used in spacecrafts as a lightweight bond solution [1]. Thermal management of spacecrafts requires crucial attention during design, manufacturing, and operation, even more with the rapid progresses in miniaturization [2]: building up of heat have been a threat on reliability and a bottleneck for innovation. A similar attention is given regarding the electrical design, with for instance grounding over the spacecraft being critical [3]. On the other hand, nano-enabling of adhesives has proven its potential in obtaining efficient thermal interface materials, in particular in electronics [4].

In this presentation, we present the development and qualification of multifunctional adhesives for applications in the space industry. We detail two study cases: a graphene enabled adhesive for insert potting and a B-stage film adhesive for electronics assembly. We report the requirements for each application, the challenges as well as the development and qualification steps.

Nano-enabled potting adhesives bring new properties to the structure itself, thus opening new design possibilities. Graphene is employed to functionalize an epoxy adhesive. Doing so, the adhesive becomes electrically and thermally conductive, while keeping its mechanical properties. At a structure level, proper engineering models were produced and tested in TVAC. The potting adhesive proved to bring a clear thermal benefit, spreading the heat efficiently and suppressing temperature differences.

Similarly, a nano-enabled B-stage film adhesive was developed in order to be implemented direclty within an electronic structure. Nano-enabling was employed to tailor multifunctional performances to the adhesive. In addition to its thermal and electrical benefice, the film adhesive was qualified for space through appropriate testing, e.g. for outgassing and ionic impurities. The film achieved is stable and easy to handle at room temperature, being suited for industrial processes used in electronics assembly. The film adhesive will be implemented in innovative RF and LF packages for spacecraft electronics.

In conclusion, these two study cases demonstrate that multifunctional nano-enabled adhesives, through the flexibility of their manufacturing and the variety of applications, can bring a significant relief on thermal and electrical management of spacecrafts in space environments.

Acknowledgments

The B-stage film adhesive has been developed with funding under the European Commission H2020 grant agreement No 821963 (Project: HEATPACK “new generation of High thErmAl efficiency componenTs PACKages for space”). The testing and qualification of the film adhesive was made in collaboration with Thales Alenia Space (France), the University of Bristol (UK) and Warsaw University of Technology (Poland). The paste adhesive has been developed under the contract 4000126884/19/NL/AR/zk from the European Space Agency (Project: HITEC “High Thermal and Electrical Conductive Bonding Materials for Space”). The testing and qualification of the paste adhesive was made in collaboration with the University of Patras (Greece) and Ruag Space Germany (Germany).

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