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► **To cite this version:**

Guilhem Rival, Eric Dantras, Thierry Paulmier. Electronic irradiation effects on the electrical behaviour of a high- performance space-used thermoplastic polymer. ISE 2019, Sep 2019, LIMERICK, Ireland. hal-02389770

**HAL Id: hal-02389770**

**<https://hal.science/hal-02389770v1>**

Submitted on 2 Dec 2019

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# Electronic irradiation effects on the electrical behaviour of a high-performance space-used thermoplastic polymer

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## Introduction

In space environment, satellite materials are subjected to several environmental constraints like high vacuum, temperature cycling or irradiation by space particles (electrons, protons, ...). In case of polymer materials, irradiation by electrons presents two major issues. Since they are electrical insulators, the accumulation of electrons on their surface will lead to electrostatic discharge phenomena that can be responsible of electrical failures. On the other hand, high-energy electrons go through the polymers and transfer part of their energy to the material, which induces different phenomena like Radiation Induced Conductivity or physico-chemical ageing. The initial physical properties of the polymer can then be modified.

In this context, numerous studies have investigated these phenomena for many space-used polymers in order to anticipate their behaviour once in orbit [1], [2]. This study focuses on PolyEtherEtherKetone (PEEK), a high-performance thermoplastic polymer which has recently but increasingly been used for space applications. Thus, it is necessary to analyse the effects of electronic irradiation on its physico-chemical structure and on its physical properties.

## Results and Discussion

100  $\mu\text{m}$  thick PEEK samples were irradiated, under high vacuum and at room temperature, in the SIRENE irradiation facility installed at ONERA, Toulouse. Two irradiations campaigns have been carried out to inject ionizing doses of 12 MGy and 34 MGy in samples.

Pristine and irradiated PEEK samples have then been analysed by Broadband Dielectric Spectroscopy. The DC conductivity data extracted for each sample at low frequency and high temperature, according to the Jonscher's law [3], have been reported in an Arrhenius plot (see Figure). With an increasing ionizing dose, DC conductivity of samples decreases indicating of a limited charge transport after irradiation. By using other analysis techniques like Differential Scanning Calorimetry (DSC), this decrease has been associated with a crosslinking phenomenon observed through the increase of glass transition temperatures. Thus, the crosslinking nodes act as new traps for electric charges. Moreover, DSC also showed a degradation

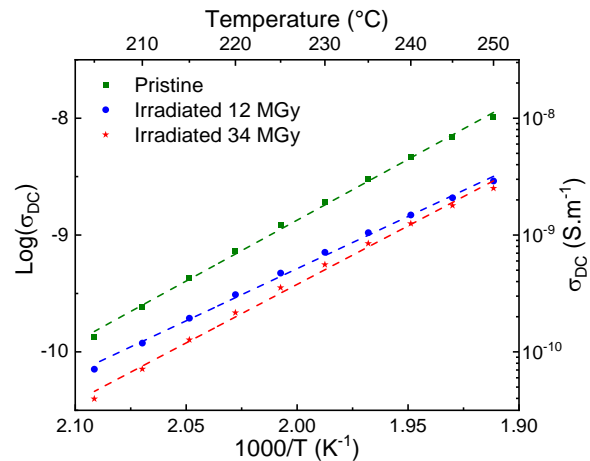


Figure: Arrhenius plot of DC conductivity of pristine and irradiated PEEK samples

of the crystalline phase and therefore, it can be supposed that defects created at the amorphous / crystal interfaces decrease conductivity as well.

## Conclusions

Irradiated PEEK samples showed a decrease of their DC conductivity associated with new charge traps created during irradiation. Thanks to different analysis, these new traps have been identified as crosslinking nodes. Thus, charge leakage being limited, this will lead to higher electrical potential on the polymer and therefore, to an increase of the risk of electrostatic discharges initiation.

## References

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## Acknowledgement

The authors would like to thank the Région Occitanie for their financial support in this project.