DETECTION OF THERMOLUMINESCENCE IN SUNLIGHT AND UV LAMP EXPOSED PEEK MATERIAL

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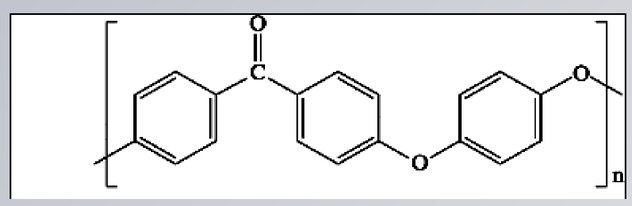
Introduction

PEEK[poly (ether ether ketone)] is a semicrystalline polymer belonging to the PAEK[poly (aryl ether ketone)] family. Due to its many good properties like wear resistance, stability at high temperatures, resistant to chemical damage and excellent mechanical properties, it is used in aerospace, automotive, chemical and manufacturing industries, **as well as in making components of orthopedic implants**. PEEK is also known to be resistant to radiation. Thus, radiation sterilization may not cause any potential damage to medical-device components. However, gamma or x-rays have shown to create free radicals in PEEK [1]. To explore the effects of low level radiation, previous CRESH student [2] used thermoluminescence (TL) technique to measure the effects of sunlight. In this study, we measured TL output following exposure to sunlight as well as UV radiation.

Our hypothesis was that UV irradiation might cause more damage to PEEK.



Materials and Method

•58 samples of PEEK VICTREX film of 10 mil were all cut to the same size (approx. 6 mm dia.).

•Being of equal thickness, all specimens weighed approximately the same (6.3 +/- 0.3 mg).

•30 samples were exposed to sunlight (UV indices are tabulated below) for 4 hours over a period of 4 days. 15 of them were tested immediately after irradiation while the other 15 were tested after keeping them in dark at room temperature for 20 hours.

•The UV Index (level of solar UV radiation) was recorded for each day[3]:

Day 1	**UV Index = 9**
Day 2	UV Index = 11
Day 3	UV Index = 9
Day 4	UV Index = 10

•28 samples were kept at a distance of 50 mm under a 26 Watt UV desert lamp in a closed glass box.

# of Samples	# of hours exposed	# of samples tested immediately	# of samples tested after 20 hours
8	6	4	4
12	4	4	8
8	2	4	4

•All the samples were tested using the Harshaw QS 3500 Thermoluminescence reader.

Data and Results

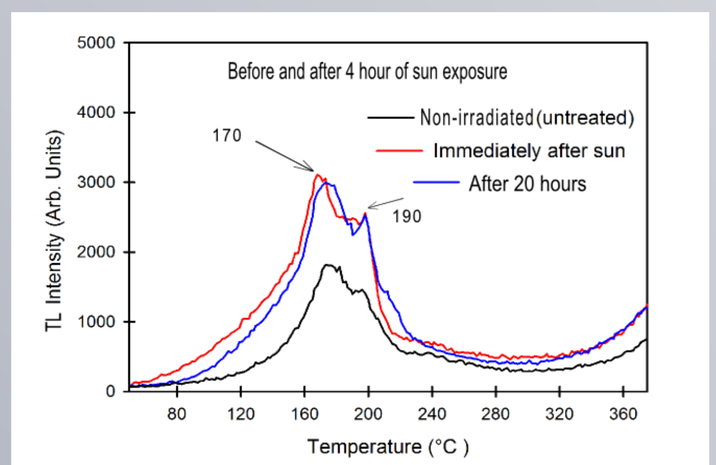


Figure 1: TL glow curve exhibits two peaks at 170°C and 190°C. While the sunlight-exposed samples produced intense TL, the non-irradiated samples (stored in lab environment for more than a year) also produced detectable TL output. No significant change in the TL output was observed 20 hours after irradiation (blue). The red and blue are average of 15 glow curves each, and the black is average of 4 glow curves.

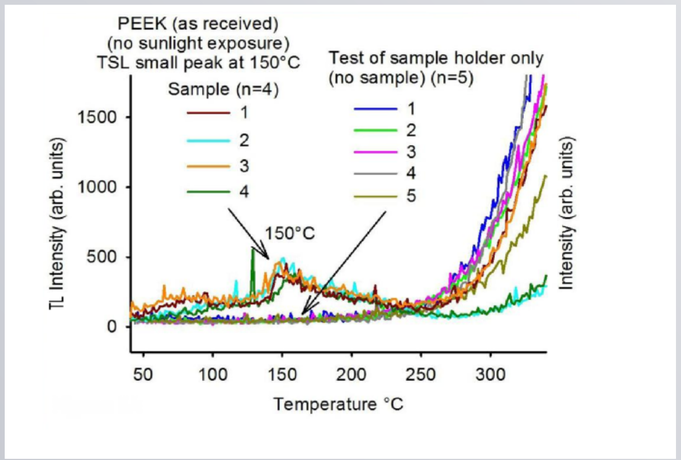


Figure 2: Compared to the base line of the TL response (without sample), as received (non-irradiated) PEEK produced weak luminescence with peak temperature of 150°C [2].

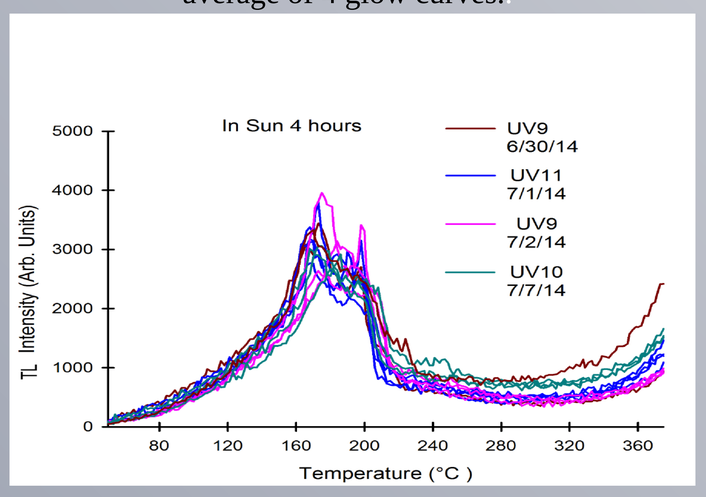


Figure 3: TL glow curves plotted as a function of UV index for each day when the samples were exposed to sunlight. The average UV index was 9.75. There was no significant difference observed between the days with different UV Index.

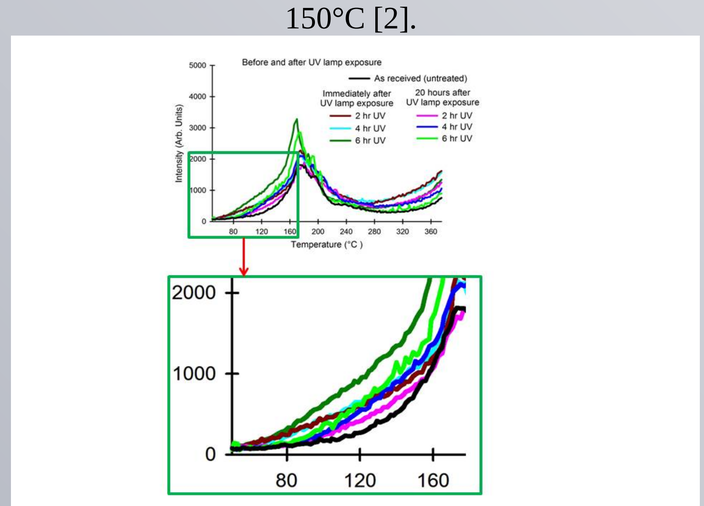


Figure 4: (a) TL output plotted as a function of UV exposure. These glow curves appear to exhibit only 170°C peak, 190°C peak is missing. However, the broad shoulder near 100°C seems to indicate the presence of additional TL (see lower figure b). As indicated by the glow curves (figure 4a), TL output decreased as a function of time following irradiation.

Summary

•Both UV and sunlight were found to cause comparable molecular level damage or trapping of charges in PEEK which led to the production of TL.

•Non-irradiated but shelf-aged PEEK was also found to produce similar TL suggesting ongoing changes in the material.

•TL glow curves of the shelf-aged or sunlight irradiated PEEK exhibited two peaks at 170° C and 190°C whereas those of the UV irradiated sample showed only one peak at 170° C.

• The UV index does not have significant effect on TL.

•The UV lamp used for this experiment had significant visible light and unknown amount of UV.

•The UV irradiation did not cause more damage than sunlight as thought which might be due to:

- the short distance of the samples from the lamp could have caused heating resulting in damage to the sample.
- the UV lamp might contain rays other than UV lights.

References

1. Dipendra A.(2013), Detection of Thermoluminescence in Polyether ether ketone, University of Memphis, Memphis.
2. Lisa M. (2013), Sunlight Induced Free Radicals and Thermoluminescence in PEEK Material, White Station High School, Memphis.
3. Live weather net, Weather bug, Web 01 July 2013.