# ELECTRON BEAM CROSSLINKING OF PE/NG NANOCOMPOSITE FOR SOLAR COLLECTOR APPLICATIONS

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Commodity plastics like polyethylene (PE) offer a cost reduction potential for use in solar thermal systems, however their application in thermal collectors, especially as absorber materials, is still rather limited [1]. The use of PE as a thermal conductive material is limited due to its low melting temperature, below 140 ◦C, and its poor dimension stability at high temperatures. Crosslinking reactions can probably compensate disadvantages of PE. Because it is well known that the three-dimensional network structure formed in PE via the crosslinking process is responsible for improved mechanical properties, such as tensile strength, hardness and the dimension stability. Among the current crosslinking ways, radiation crosslinking could be an efficient way to get crosslinked PE without any additives and chemical pollutions [2]. On the other hand, due to the excellent properties of the nanographite pigment, it may fulfil the requirements of high absorbance in the solar absorber materials [3]. The main emphasis of this work is to study the thermal and aging behaviours of the radiation-crosslinked polyethylene containing nanosized graphite under stagnation conditions related to solar thermal applications.

For this purpose, PE/NG composites containing 2.25% nanographite was prepared through masterbatch preparation and then melt extrusion process. SEM images of the PE/NG 2.25% sample proved a good dispersion of NG in polymer matrix (Fig. 1).

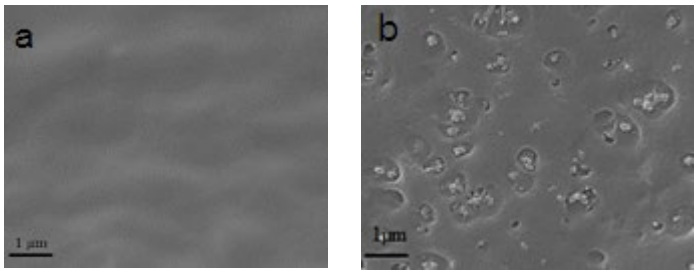


*FIG.1. SEM images of (a) PE (b) PE/NG composite.*

The results of hot creep and hot set measurements for PE/NG 2.25% are depicted in Table 1. As observed, the unirradiated sample melts rapidly at 150 °C, so that fail immediately. For irradiated samples by increasing of the irradiation dose to 200 kGy, hot creep decreases, indicating that high amount of crosslink density formed with increasing dose. The higher concentration of crosslinks leads to a longer resistant time in the hot creep condition, indicating improved thermal stability of the samples. In addition, hot set results show that after cooling, irradiated sample at 200 kGy has the lowest extension. This means that even if the irradiated nanocomposite exposed to 150°C in the stagnation condition, after cooling it nearly goes back to its original form which is important property in the solar thermal absorber applications.

TABLE 1. HOT SET RESULTS OF IRRADIATED PE/NG

| Dose (kGy) | 0 | 100 | 150 | 200 |
|---|---|---|---|---|
| Hot creep (%) | - | 72 | 56 | 44 |
| Hot set (%) | - | 5.2 | 4.8 | 2 |

Differential Scanning Calorimetry (DSC) analysis of 100 kGy irradiated sample in hot air at 140 °C for 100, 200 and 400 h are shown in Fig. 2. It is found that thermal aging causes a prominent increase in melting point and degree of crystallinity during initial 100 h, followed by a slower increase at longer aging times. This increase in crystallinity could be due to additional crystallization and formation of new crystals in the interface between NG nanoparticles and polymer matrix by thermal aging [4].

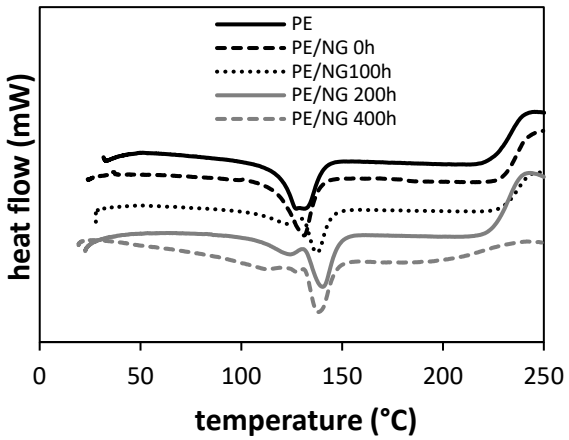


*FIG. 2. DSC thermograms of irradiated PE/NG composites after exposing to air at 140 °C.*

Altogether, radiation crosslinked PE/NG containing 2.25% NG at 100 kGy appears to be a promising candidate for application as a black absorber material for solar thermal collectors.

## REFERENCES

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