II SENCiR

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A New Radiochromic Dosimeter Based on Aliphatic-Aromatic Biodegradable Polymers

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The use of high doses of gamma and electron radiation in industrial processes has encountered several applications in different fields, as for example in the sterilization of medical products, to modify polymer properties and in food irradiation. In this work we propose a new radiochromic dosimeter based on biodegradable poly(butylene adipate-co-terephthalate) copolymers (PBAT). A non photoluminescent commercial type of PBAT copolymer is chemically handled in order to become photoluminescent. The new dosimeter is environ-mentally friendly to help for waste reduction, cheap (U$ < 0.5), easy to process, very flexible and simple to read, without dependence on expensive, complex instruments and trained personal.

PBAT was obtained from BASF, Brazil, and dissolved in chloroform. The copolymer is mixed with a photo-chemical agent to produce photoluminescent PBAT solutions and films of about 100 μm thick by casting. The irradiation of samples was performed at room temperature at the Irradiation Gamma Laboratory facilities of CDTN-Centro de Desenvolvimento da Tecnologia Nuclear, using a Co–60 source at a constant dose rate of 20 kGy/h for doses ranging from 1 to 2000 kGy. A 405nm LED light source is used to excite the films. A USB2000 spectrometer made by Ocean Optics collects the emission spectra. Fig. 1 and Fig. 2 displays the effect of the gamma radiation doses of 100, 200, 300, 400, 500, 600, 800, 900, 1,000 and 1,750 kGy delivered by a Co-60 source on the variation of UV-Vis absorption (ABS) and photoemission (PL) properties of PBAT films, respectively. There is a gradual increase of absorbance for lower wavelengths (320–460 nm), with similar absorption intensities for all gamma doses and consequently to the PL, according to the Stokes shift. This result represents the discovery of a technique (patent required), very effective to transform the biodegradable aliphatic-aromatic polymer (PBAT) in the first aliphatic-aromatic photoluminescent biodegradable polymer (PLBP). Furthermore, both PL and ABS present a linear radiation dose dependence, and a systematic study shows that the intensity of the radio-induced PL is linear with the applied dose as we can see at Fig 3. The green photoluminescence obtained when excited at 405 nm is very stable and gradually changes its color from a dark green to a very clear green for doses ranging from 100 kGy to 1.75 MGy, respectively, as shown in Fig. 3. The tunable photoluminescent property (Fig. 2 and 3), together with biodegradable feature of PBAT, indicates that gamma irradiated PBAT could have potential for applications in *in vitro* and *in vivo* imaging of human breast cancer SK-BR-3 cells and bio-imaging devices. By these applications we mean that the photoluminescent PBAT copolymer can be transported to cancer cells by silica mesoporous nanoparticles, together with the drugs necessary to treat the tumor, making them to emit visible green light, as illustrated in Fig. 6.

Tunable Photoluminescence Intensity

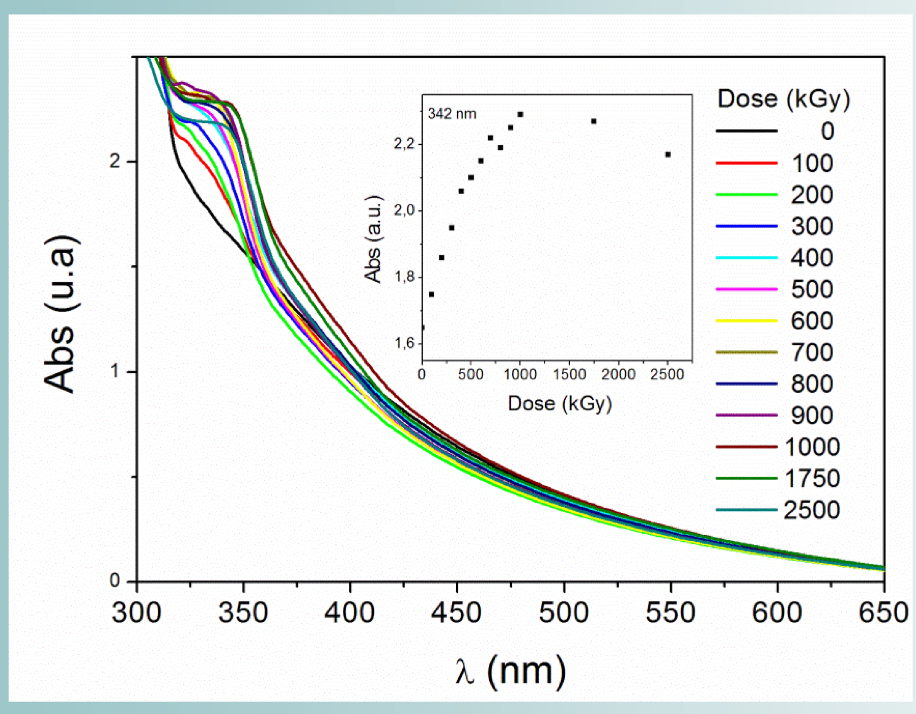

Fig. 1 UV-Vis absorbance spectra for PBAT copolymers irradiated with gamma doses. The inset shows the absorbance intensity at 342 nm as a function of gamma dose.

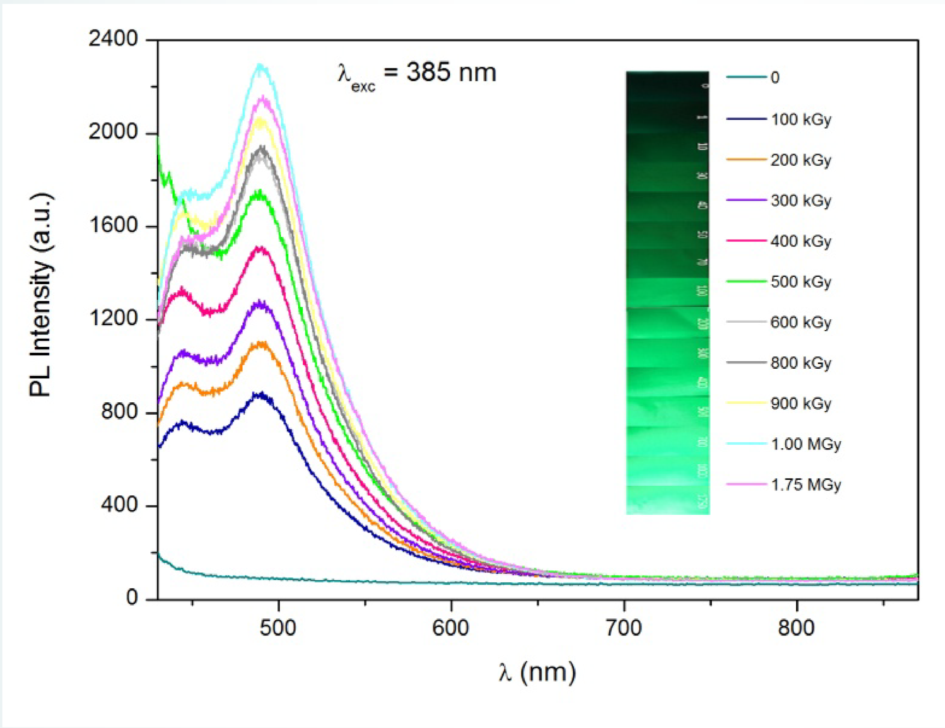

Fig. 2 Photo-stimulated luminescent emission spectra of PBAT excited with LED source at 385 nm, for doses ranging from 0.0 to 1.75 MGy. The Corresponding photos taken during excitation vary from dark green (0.0 kGy) to very bright green (1.75 kGy), for increasing doses.

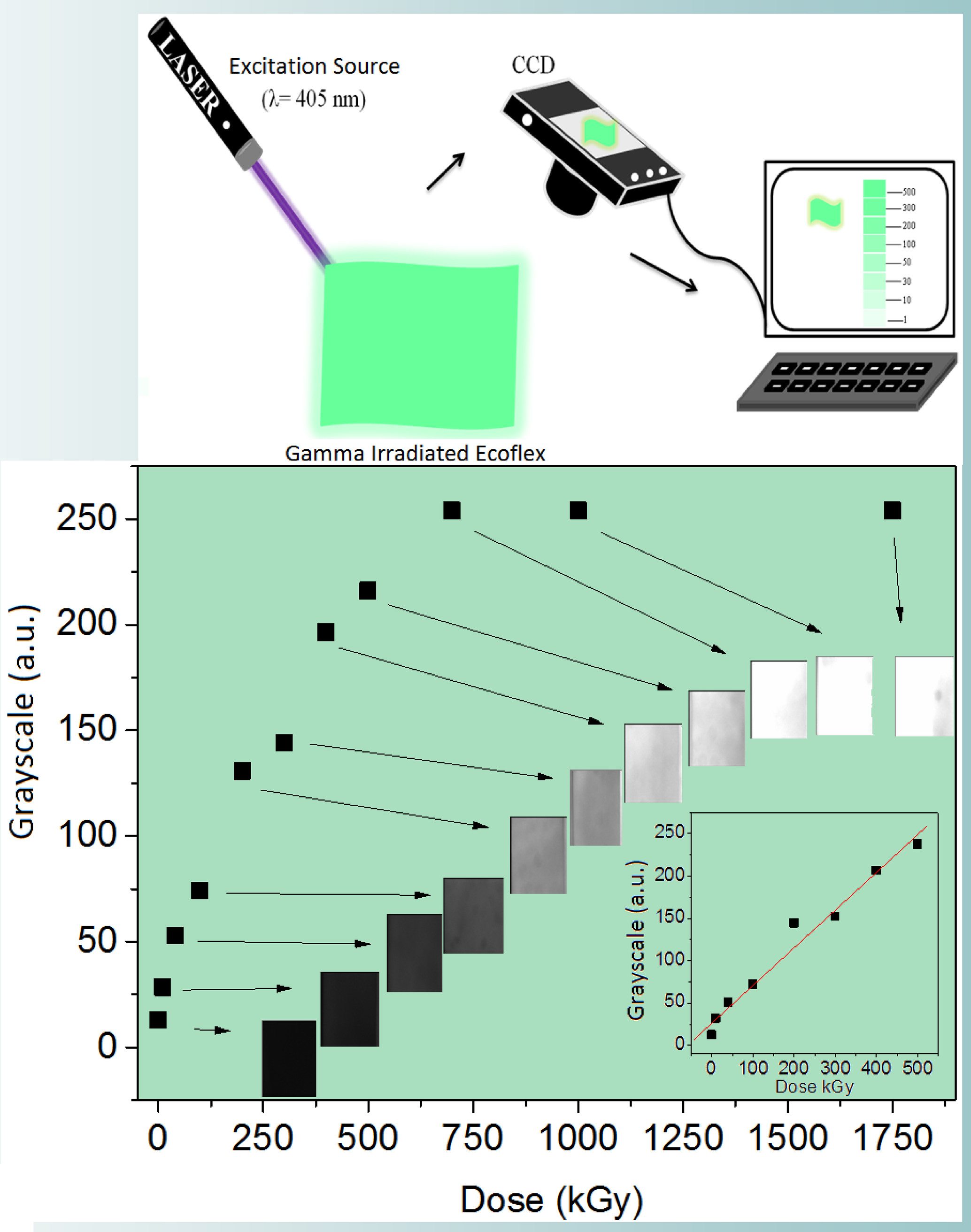

Fig. 3 Grayscale from 0 to 255 images using the camera from Hamamatsu PBAT films irradiated with different doses of gamma radiation

Proposed Mechanism

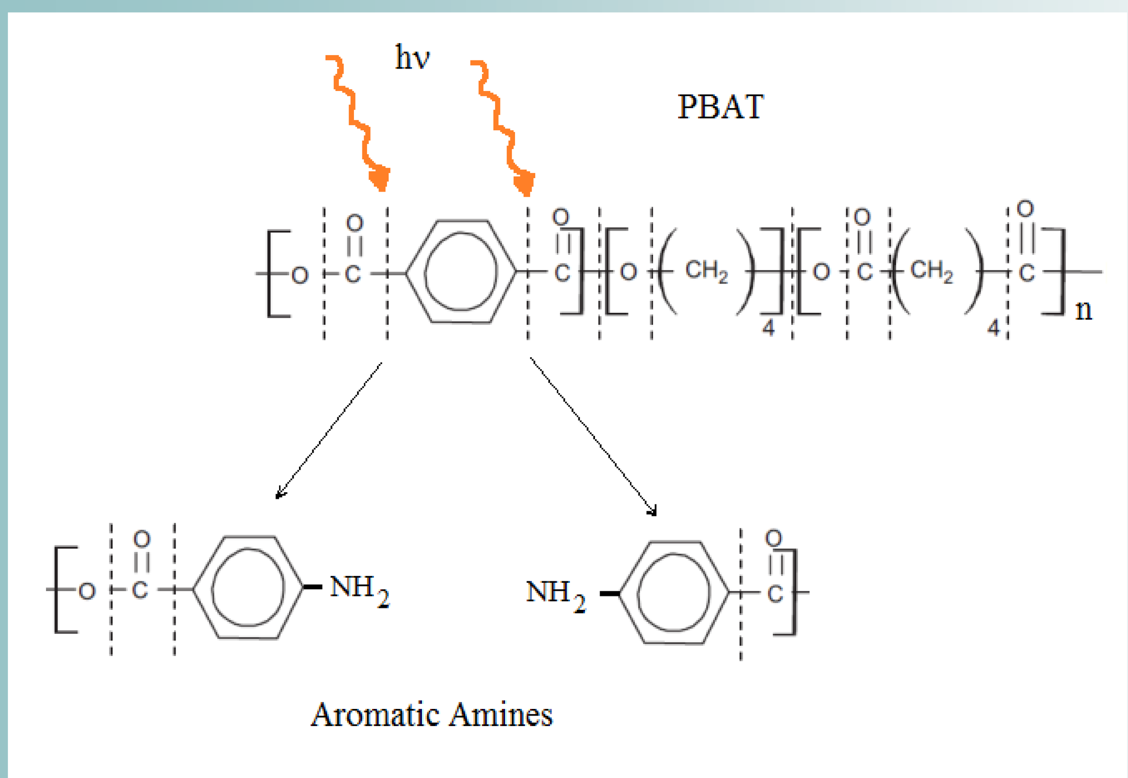

Fig. 4 Structure of PBAT and chemical bonds that could be broken by gamma radiation, provoking chain scission. Photoluminescent aromatic amines could be formed by linking a hydrocarbon ring with an NH_2 molecule.

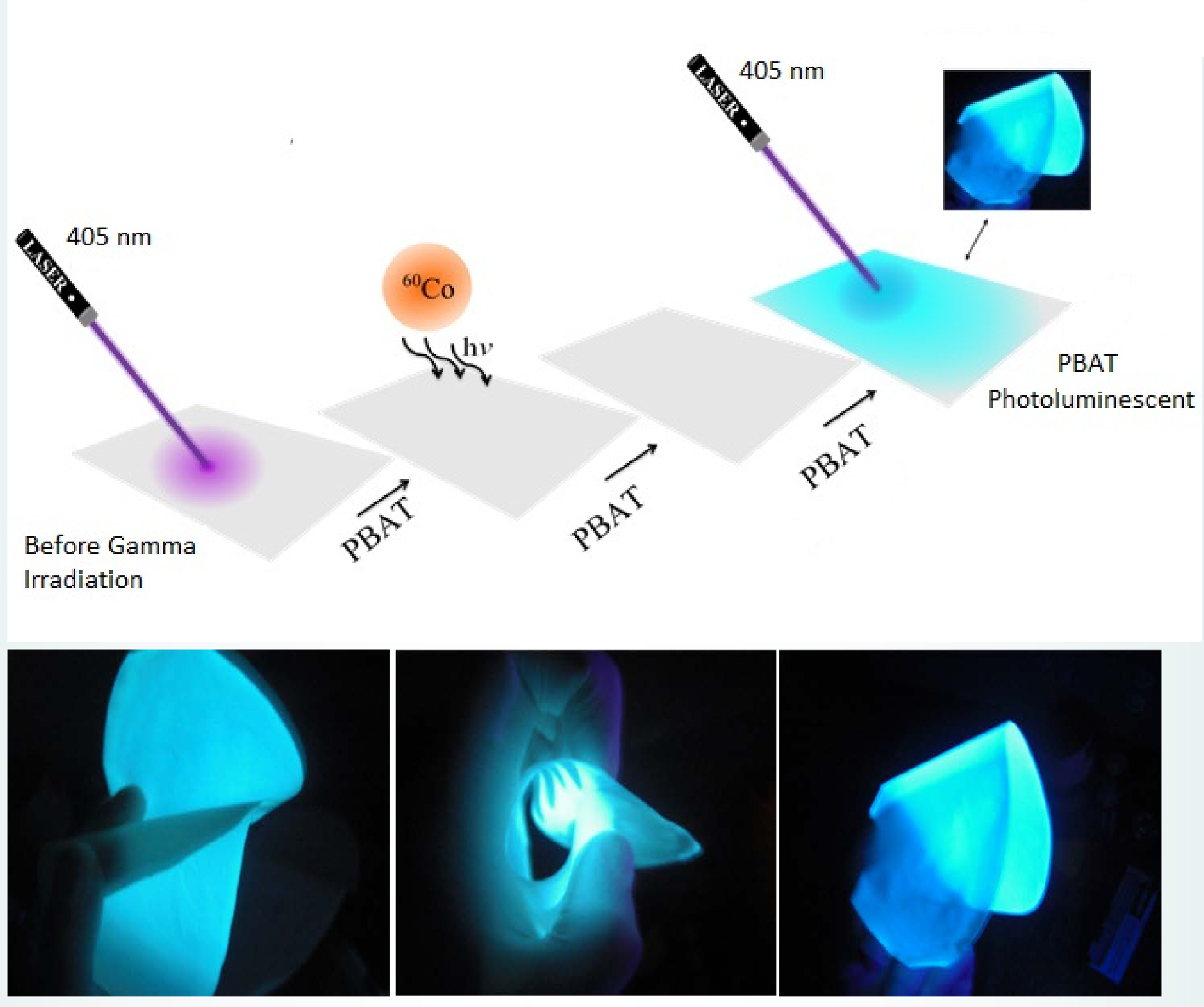

Fig. 5 Schematic drawing of radio-induced tunable photoluminescence in PBAT copolymers

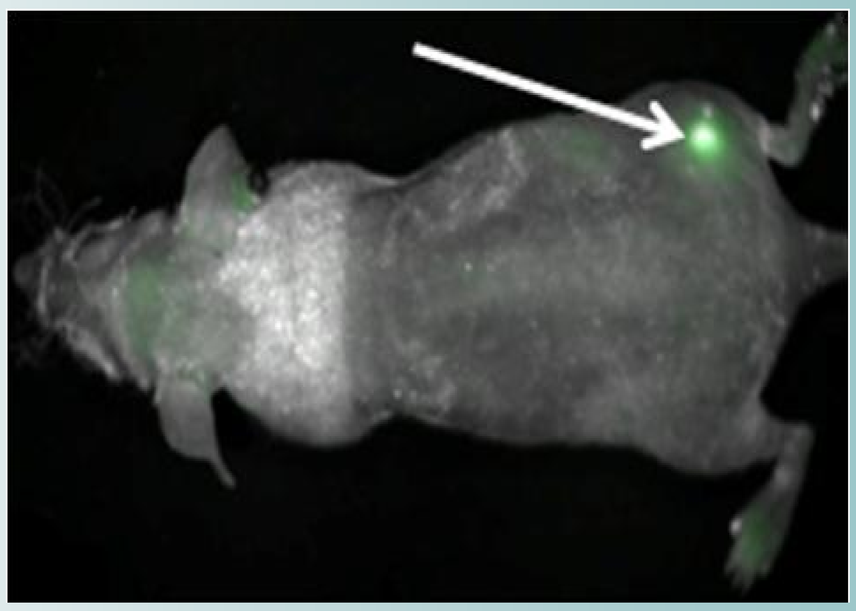

Fig. 6 Example of application in Bioimaging Devices using a BPLP developed by Jian Yang *et al. to visualize in vivo* cancer image.

References

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CNEN Comissão Nacional de Energia Nuclear
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