Radiation sensors based on the generation of protons in polymeric gate dielectrics

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Ionizing radiation (IonR) has practical uses in many areas such as nuclear science, medicine, food industry and environment. For most applications and personal safety concerns, accurate monitoring and control of the radiation dose is necessary. Depending on the radiation type and dose level to be detected, a wide variety of radiation detection and measurement devices have been developed [1]. Recently, a new sensing scheme based on mobile protons generated by radiation, including IonR, in organic gate dielectrics has been proposed for the development of metal-insulator-semiconductor (MIS)-type dosimeters [2] (Fig.1).

In the present work we explore triphenylsulfonium nonaflate (TPSNF) and triphenylsulfonium hexafluoroantimonate (TPS-SbF6) photoacid generator PAG-containing polymeric materials as the radiation-sensitive gate dielectric of organic MIS dosimeters using P3HT, as organic semiconductor material (see Fig. 2). The effect of UV and X-ray irradiation on the high-frequency (HF, 1 MHz) capacitance versus the gate voltage (C–V_G) curves characteristics of the MIS devices was investigated for different total dose values. The bistable behavior of a MIS device using a TPSNF−PMMA layer as gate dielectric after UV exposure is evidenced by the C−V_G hysteresis loops shown in Figures 2. The presence of mobile ions in the PMMA matrix has been ruled-out, as the reference devices using a spin-coated PMMA layer do not exhibit any proton-related shift in the C−V_G characteristics. Additional features such as the UV-Vis monitoring of photoacid generation through the use of an acid indicator and preliminary results of the drain current vs. gate voltage of hybrid Si-based MISFET and organic FET transistors with radiation-sensitive gate dielectrics will be presented at the conference.

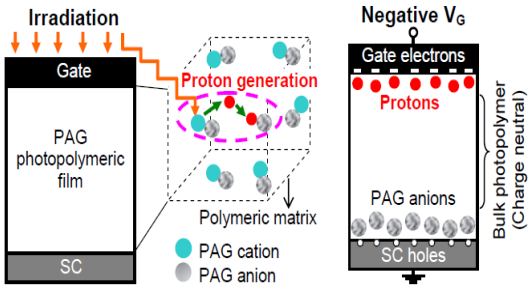

Figure 1: Radiation sensor MIS capacitor made by sandwiching a PAG embedded photopolymeric layer between two electrodes made of semi-conductor, SC, and metal materials. Operation principle upon application of negative gate voltage.

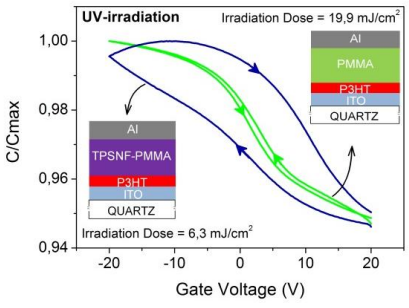

Figure 2: C–V_G curves of organic MIS capacitors after exposure to UV light with a cross-section structure shown in the inset.

[1] Knoll G. F. In Radiation Detection and Measurement; Wiley: New York, 2000.
[2] Kapetanakis E. *et al.*, ACS Appl. Mater. Interfaces **5**, 5667 (2013).
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