

Visual Indicators of Ionizing Radiation Based on Organic Radio- and Photochromic Materials

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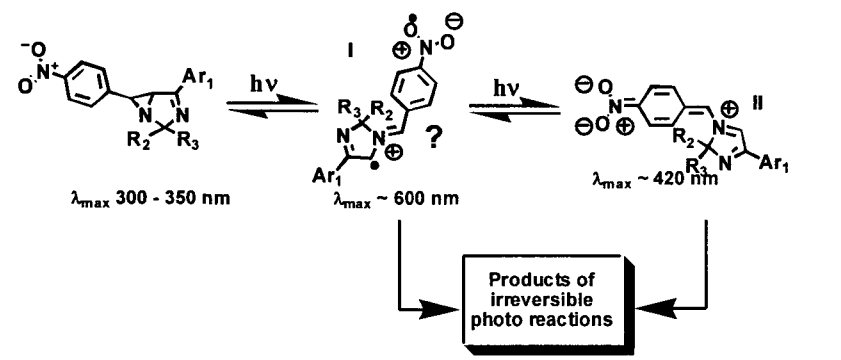
The use of organic scintillators usually is based on the conversion of radiation into light and subsequent detection with photosensitive cell. Most of the instruments operating on this principle register total dose (or intensity) of the radiation regardless of its source and direction.

Another method of detection is concerned with using of materials that can change their color under the radiation. They can contain compounds directly responding to the radiation (radiochromes) or responding to UV or visible light (photochromes). The last must be used in combination with corresponding scintillators producing UV irradiation.

Both these ways demand new high photo- or radiosensitive substances. During the last years a series of such organic compounds has been discovered and studied. We concentrate our attention on bicyclic derivatives of aziridine 1,2,3.

These compounds are unique in respect of the visual photosensitivity. In their case high photoresponse is combined with contrast range (the depth of photo-induced form coloration) and with high extinction.

The photo- and radiochromic properties of bicyclic aziridines is concerned with reversible ring-open process leading to bipolar structures. Our investigations showed that the induced ring-opening has two steps mechanism.

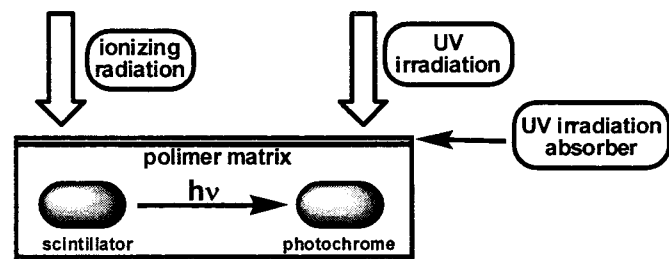


In the context of the present work we considered the following basic way of radiosensitive indicator formation: combine polymeric scintillator (polymer with scintillator additives) with photochromic organic compound spreading throughout the all volume of polymer.

We investigated various combinations of scintillation additives and photochromic compounds. At that, the minimal overlapping of absorption bands of an additive and a photochromic compound, and maximal overlapping of the emission band of an additive and

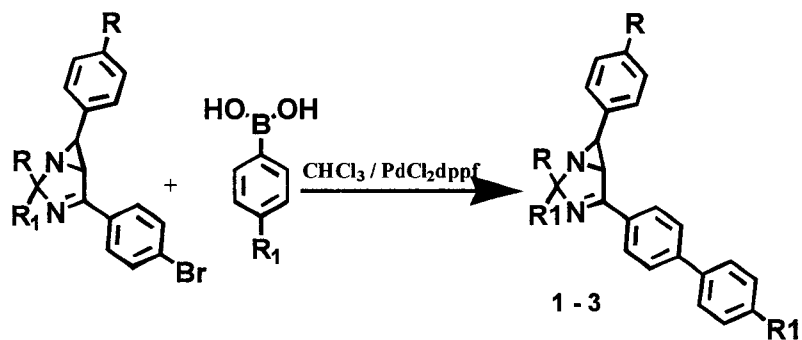
absorption band of a photochrome were considered as a preliminary criterion in their aimed synthesis.

On basis of our investigation the possible composition of polymeric radiosensitive indicator was proposed:



Another direction of highly sensitive radiochromic materials creation is concerned with an idea of combination of both photochromic (aziridine) and radiophoric (polyarene) fragments in one molecule.

The choice of synthesis objects was determined by the aims of investigation (at least one of the substituents should have polyarene nature), and also by the previously obtained data stating that nitro-derivatives have the highest photosensitivity and depth of photo-induced form coloration. We have developed a new approach involving Suzuki reaction concluding interaction of halogen derivatives of bicyclic aziridines with arylboronic acids in the presence of palladium catalyst. It should be mentioned that it was actually the first case of use of this reaction in aziridine chemistry.



We have also carried out a preliminary testing of radiochromic properties of the compounds obtained. We investigated their behavior under the action of β -rays (the source used was Sr90 with energy 543/3 keV and Y90 with energy 2624 keV) and X-rays (an unfiltered radiation of a molybdenum tube). The investigation showed that all the substances obtained display sufficiently high sensitivity towards these kinds of radiation.