OG 4.4-11.

EXPERIMENTAL TEST FOR INTERPRETING THE INCREASE IN SENSIBILITY OF DOPED CR-39.

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1. Introduction. In recent years the sensibility of CR-39 to nuclear tracks has been increased by doping the corresponding monomer with dioctyl phtalate. At this regard, two theoretical approaches are currently managed to explain this phenomenon: either the doping react with the active radicals in the chain blocking them, stopping crosslinking between chains, or alternatively that the doping gets between them giving wider space between the crosslinked chains.

We delimitate the contribution of each one of these effects in increasing sensibility by applying experimental techniques that will only block the active radicals of the chain.

Since the discovery that dioctyl phtalate (DOP) as a dopant, increases the sensibility of the plastic CR-39 [4], other dopants had been tested. This dopants were generally heavy phtalic esters, as was originally suggested in [4].

We believe that phtalic esters may have twoo possible ways of reacting. Either they can react completely with the active radicals in the monomer bloking and by this stopping crosslinking, or, as they have two reactive sites, they can react with two monomers belonging to two different chains, and by this not to stop crosslinking, but widening the space between crosslinked chains.

Terephtalic esters are suitable dopant openers of crosslinked chains and had also been used showing no great difference in sensibility as compared to the use of phtalic esters.

Here we use benzoic esters, which would be considered as blockers having just only one reactive site, as dopants, to see if they can increase the sensibility of CR-39.

An increase in sensibility with benzoic esters compared to the phtalic or terephtalic esters, would prove that the sensibility in CR-39 is increased by the dopant to stop crosslinking and not by widening the space between crosslinked chains.

2. Theory. When the monomer- dietilen glycol bis allyl carbonate- is catalyzed by the initiator, the monomer forms what is called free radicals. This free radicals are able to combine themselves within each other to form the polymer chain. However the free radicals of this monomer have two free electrons at both ends of the monomer molecule, which can become two covalent bonds at the ends of the molecule. This makes it possible for different chains which have only use one of the free electrons

to make the chain and leave the other electron for possible interaction between chains to form a covalent bond between them. This is what is call crosslinking.

If a phtalic ester (heavy) is added when polimerization starts, then the free radicals of monomer induce an inestability between the carboxilic group in the ester and the heavy chain attached to it; causing the ester to break also in free radicals precisely in this bond. The carboxilic group free radical has two oxigens with one free electron each, capable to react and form a covalent bond. So it can react with one monomer in one chain and at the same time, with another monomer in another chain, therefore widening the space between these two crosslinked chains. However, it can happen that only one oxygen has lost his heavy chain and just one electron is now available for reaction. If this happens then the ester will react with only one monomer in one chain, thus blocking that possibility for crosslinking and by this reduce and eventually stop the possibility for crosslinking. On the other side the heavy chain free radical can only interact as blocker.

The purpose of using benzoic esters instead of phtalic or terephtalic esters is that when breaking in free radicals, they can only have one electron for forming a covalent bond. Therefore they will only work stopping the crosslinking between chains. If the sensibility is the same as with the other esters, then phtalic esters work as blockers. If the sensibility decreases, then the phtalic esters work as openers.However if the sensibility increases, then we can not say anything about the work of the phtalic esters but a better dopant has been found.

3.Experimental. Five different preparations were made using the french monomer C.A.D. from the Société Française D'organo-synthèse. Each preparation was polymerized using as initiator 3% by weight of asoisobutironitryl (AIBN) from Dupont (peroxidicarbonates were not available in our country), and four of them were dopped with different esters according to TABLE I. All five polymers were polymerized at the same time, in the same oven with a thirtytwo hour curing cycle [1],[2].

TABLE 1.- INITIATOR AND DOPANT USE IN EACH POLYMER.

PREPARATION N°	NAME	INITIATOR	INITIATOR CONC.	DOPANT	DOPANT CONC.
1	CR-39	AIBN	3%	—	—
2	CR-39(DOP)	AIBN	3%	DOP	3%
3	CR-39(MB)	AIBN	3%	MB	3%
4	CR-39(BB)	AIBN	3%	BB	3%
5	CR-39(SB)	AIBN	3%	SB	3%

AIBN= asoisobutironitryl; DOP= dioctyl phtalate; MB= methyl benzoate; BB= benzyl benzoate; SB= sodium benzoate.

After the curing cycle was completed, the plastics thus obtained where soft and flexible. We irradiated them, together with some samples of CR-39 (DOP) from Pershore Mouldings Ltd., with α-particles at different energies. We then etched them in a solution 25% NaOH at 70°C in three steps. A first step of two hours, a second one of two hours nineteen minutes and a third one of three hours .

4. Preliminary inference. At the time this confirming abstract was done, analysis of the irradiated plastics was in progress. The analysis will end with calibration curves describing the track velocity of attack as a function of the residual range, which would show the sensibility of each polymer compared to CR-39 (DOP) by Pershore.

Though analysis is not yet complete, some preliminary inferences can be made: From the size of the tracks in our five plastics compared to the size of the tracks in the CR-39 (DOP) from Pershore,we can infer that the sensibility of our plastics should be about the same as the CR-39 (DOP) from Pershore. Though, this should not be conclusive since calibration curves have not been obtained yet.If this inference results in becoming true, we would have proved then, that DOP works as a blocker and not as an opener that widens the space between crosslinked chains.

At the moment being, we have a conclusive result. This is that the tracks in the polymer doped with sodium benzoate are very hard to analyze since the polymer is quite turbid.

5. Acknowledgements.We are indebted to Dr. Miguel Balcázar for the facilities in the use of his nuclear track laboratory during the phase of irradiation, etching and observation of the tracks.

References.

1. Adams,Jr. J.H., (1981), Proc. 11th Int. Conf. on SSNTD, Bristol,145-148.
2. Société Française D'Organo-synthèse, (1984), Report JE/NC 27/2/84.
3. Somogyi, G., (1981), Proc. 11th Int. Conf. on SSNTD,Bristol, 101-113.
4. Tarlé, G., (1981), Proc. 17th Int. Cosmic Ray Conf.,Paris, T2-13,74-77.

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