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CHEMICAL EFFECTS OF THE $^{79}\text{Br}(\gamma, 2n)^{77}\text{Br}$ NUCLEAR REACTION IN K_2ReBr_6 - K_2ReCl_6 MIXED CRYSTALS

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Abstract. — In continuation of investigations of the chemical fate of (n, γ) and (γ, n) produced Re recoil atoms in K_2ReBr_6 - K_2SnCl_6 [1, 2] and K_2ReBr_6 - K_2OsCl_6 [3] mixed crystals and IT and (n, γ) produced Br recoil atoms in K_2ReBr_6 - K_2SnCl_6 [4] and K_2ReBr_6 - K_2ReCl_6 [5] mixed crystals we have investigated recently the chemical effects of ^{77}Br recoil atoms in the K_2ReBr_6 - K_2ReCl_6 system activated by the nuclear reaction $^{79}\text{Br}(\gamma, 2n)^{77}\text{Br}$. By using ion exchange column chromatography as a new method of separation of the mixed $\text{Re}^{77}\text{BrBr}_{5-n}\text{Cl}_n^{2-}$ species larger amounts of the irradiated material could be separated following the dissolution. The yield of $\text{Re}^{77}\text{BrBr}_3^{2-}$ increases, the yield of $\text{Re}^{77}\text{BrCl}_3^{2-}$ decreases significantly with increasing K_2ReBr_6 concentration, all the other mixed hexabromochlororhenates and the free bromide- (^{77}Br) are only little dependent of the mixed crystal composition at least at concentrations below 50 mol-% K_2ReBr_6 . For zero K_2ReBr_6 content we obtained by extrapolation :

$^{77}\text{Br}^-$	16 %
$\text{Re}^{77}\text{BrBr}_3^{2-}$	3 %
$\text{Re}^{77}\text{BrBr}_4\text{Cl}^{2-}$	5 %
$\text{Re}^{77}\text{BrBr}_3\text{Cl}_2^{2-}$	5 %
$\text{Re}^{77}\text{BrBr}_2\text{Cl}_3^{2-}$	6 %
$\text{Re}^{77}\text{BrBrCl}_4^{2-}$	16 %
$\text{Re}^{77}\text{BrCl}_5^{2-}$	49 %

The total bromine content (active ^{77}Br and inactive $^{79,81}\text{Br}$) of the recoil labelled species amounts to 31 % at zero K_2ReBr_6 concentration clearly indicating that on the average two bromide ligands (one of them being ^{77}Br , the other inactive) of the original six survive the nuclear process and are still bonded to their original Re central atom. Especially the appearance of the more intimately mixed species cannot be explained by models discussed hitherto in the literature [6] (billiard ball impact, ligand vacancy exchange followed by combination [7], hot spot reaction). We propose here a new mechanism which we want to call the *Inverse Cage Effect*. Following this model Br recoil atoms that are directed towards the central atom transfer their kinetic energy via the central atom to all or part of the other ligands which are driven in the surrounding lattice. The newly formed vacancies are then filled by halide ions from the environment including the ligands just pushed away.

The experimental results may be summarized as follows : Besides a very small yield of primary retention ($\text{Re}^{77}\text{BrBr}_3^{2-}$) one third of the recoil bromine atoms react following the inverse cage effect, two third are caught as interstitials ($^{77}\text{Br}^-$) or undergo simple displacements ($\text{Re}^{77}\text{BrCl}_3^{2-}$).

The recoil energy of the ^{77}Br is estimated to be not larger than ca. 1 keV. This suggests that the nuclear reaction $^{79}\text{Br}(\gamma, 2n)^{77}\text{Br}$ is far from a compound nuclear mechanism.

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DISCUSSION

H. ACKERMANN. — What has been your experimental procedure ?

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The ^{77}Br activity has been determined using the 239 and 520 keV gamma lines measured with a Ge(Li) detector-multi channel analyser system.