Formation of yttrium iron garnet and yttrium perovskite from yttrium and iron oxides has been studied in sandwich-type diffusion couples. We have been investigating reaction rates and reaction mechanisms as well as magnetic structures of the product phases and the microwave properties of the materials. The reaction proceeds by one-way diffusion of cations and anions. Thermally decomposed hydroxides have also been used as starting materials. In this case analysis was made by EPR. In addition to YFeO₃ and Y₃Fe₅O₁₂, YFe₂O₄ (stable only at reduced oxygen pressure) occurs in the phase diagram.

Garnet formation and phase transitions were observed in a special high temperature ESR cavity at temperatures above 850 K.

Our results on reaction rates may be interpreted in terms of a reaction model developed by Schmalzried (Z. Phys. Chem. N.F. (1962), 33, 111).

The assertion that the diameter of NH₄⁺ is too large to permit this ion to be in a nesting position in a complex is clearly incorrect. In the hydroxylammonium complex, the nitrogen atom of the NH₄⁺ group lies about 0.68Å from the median plane of the six oxygen atoms of the crown ring in a nesting position, just 0.11Å from this plane. It is hydrogen bonded to the lower triangle of oxygen atoms; the –NH₂ group lies about 0.68Å from the median plane of the six oxygen atoms of the upper triangle of oxygen atoms; the –NH₃⁺ group is hydrogen bonded to the crown ring in the host, one of these bonds being bifurcated, involving a perchlorate oxygen atom as well:

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A 16 mm movie will be shown in real time of (1) metal/oxygen interaction and (2) oxide dissolution by water vapour in situ in the electron microscope. Palladium metal is seen to react with magnesium oxide via a liquid-like phase. The reaction is a surface reaction in the sense that it is limited to a few tens of Angstroms in depth and does not introduce strain into the oxide lattice. Eventually the oxide is entirely "eaten".

Aluminum oxide spheres are observed in dissolution to change from spheres to rather grotesque, intergrown single crystals. Cubic crystals of magnesium oxide can be seen to be attacked primarily on the main (100) faces rather than the cube edges or corners.