

The kinetics of oxygen atom reactions using a flow method

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Practical:

Abstract

Early this century, Lord Rayleigh discovered that atomic oxygen is one of the products of an electric discharge through molecular oxygen. (The Rayleigh referred to is R.J.Strutt, 4th Lord Rayleigh, known as 'airglow Rayleigh' to distinguish him from the 3rd Baron, or 'scattering Rayleigh'.) Relative concentrations of up to 10% may easily be produced in this way, although in this experiment we shall use smaller values at low total pressure to simplify the reactions in the system. Atomic oxygen is not, of course, an intrinsically unstable species, but it is highly reactive. It is therefore not possible to study it in an ordinary static system, and a flow method must be employed instead.

Intended academic level

Physical chemistry experiment at the 2nd or 3rd year level

Duration

3-4 hours

Outcomes

Experience in the handling of low pressure gases and use of vacuum lines, photomultiplier detection of low light levels. Experience in the calculation of rate constants and related data for gas-phase reactions.

Materials

Custom-built gas handling line incorporating electrical discharge section and pressure control and measurement modules. Photomultiplier-based light measuring system (a lower-sensitivity arrangement could also be used).

Costs

Gas-handling line requires specialised construction, but this could be completed by a typical scientific glassblower; costs for gas line ca. £250 including needle valves. High voltage source, photomultiplier tube with power supply, rotary pump ca. £1500-2000. A nitrogen/oxygen mix is required as the gas feed. This is best purchased commercially at a cost of around £80 for a full-size cylinder. However, gas consumption is small and a full cylinder is likely to last a couple of years or more.

Further comments

A high voltage source is required to produce the oxygen atoms. This presents a significant hazard. It is therefore important that the electrodes across which the voltage is established, and the leads to them, be inaccessible to those doing the experiment.

Reading

Experiment script, available from the URL given above

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