

Appendix A

Circuit diagrams of in-house electronics

Mass filter magnet power supply

Figure A.1 shows the circuit diagram for the mass filter magnet power supply. An Omega 400 B2 switched mode power supply provides a steady 26 V at up to 15 A, which is then current regulated by the circuit shown. An operational amplifier (LM355N) compares the voltage drop across the 0.01 Ω current sensing resistor with the voltage set by the potentiometer. If the voltage drop is larger, then the impedance of the J217 JFETs increases to reduce the current and balance the circuit. The power diode on the output is to prevent the self-inductance of the magnet from damaging the power supply if the current is reduced too rapidly. On no account should the reversing switch on the output be changed when current is running through the magnet.

Ion source power supply

The ion source power supply, shown in figure A.2, provides a.c. power to heat the cathode, floating on the cathode bias voltage. Point K is grounded for normal operation (floating beam). Power for the cathode is adjusted manually with a variable transformer. A TL783C voltage regulator is used to control the bias voltage. The 5 k Ω variable resistor sets the bias voltage, and the 100 Ω variable resistor is used to calibrate the emission current measurement. The 120 V zener diode was found to be necessary to protect the voltage regulator against voltage spikes.

Crucible temperature controller

The crucible temperature controller (figure A.3) utilises an LT1025 cold junction compensator and matched CA3140E amplifier to convert the type C (tungsten 5% rhenium, tungsten 26% rhenium) thermocouple voltage into a temperature reading. The

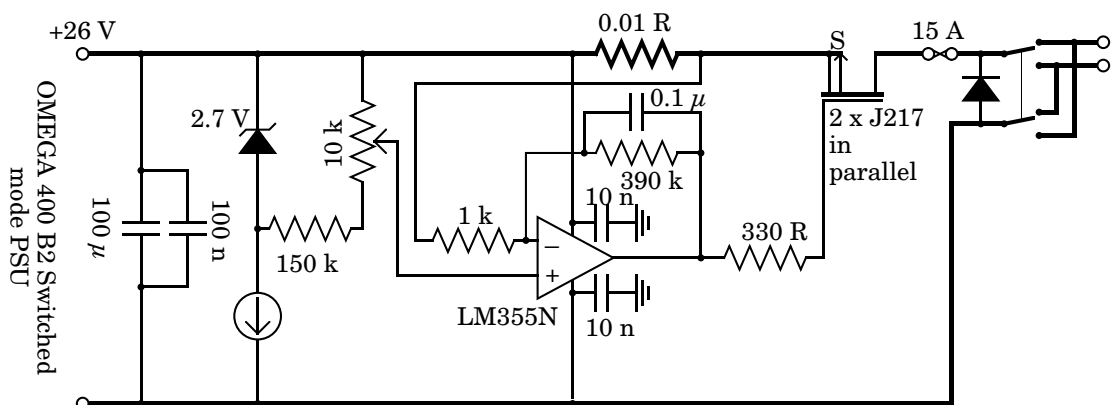


Figure A.1 Mass filter magnet power supply

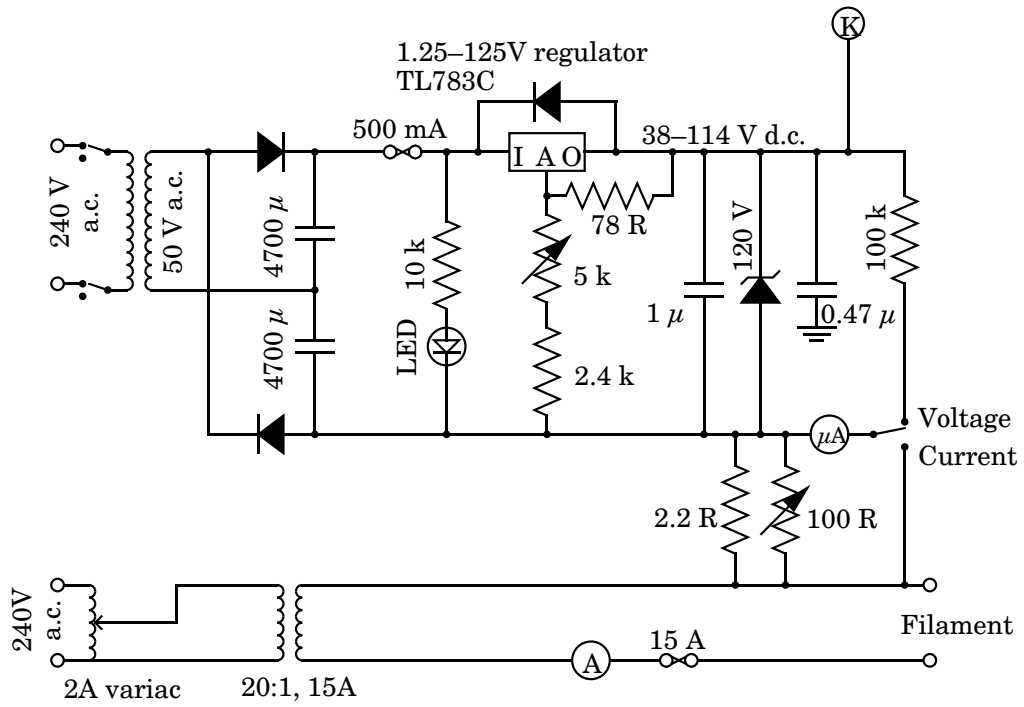


Figure A.2 Ion source power supply

controller circuit is not grounded so that the thermocouple does not need to be insulated from conducting parts of the cluster source. Calibration includes an offset voltage, which can be used to improve the accuracy of the thermocouple voltage to temperature conversion over a limited temperature range. A comparator (LM311N) switches off the power to the crucible by a solid state relay when the thermocouple temperature exceeds the temperature set by the 10 kΩ ten-turn potentiometer. The snubber is necessary because the load being switched is inductive.

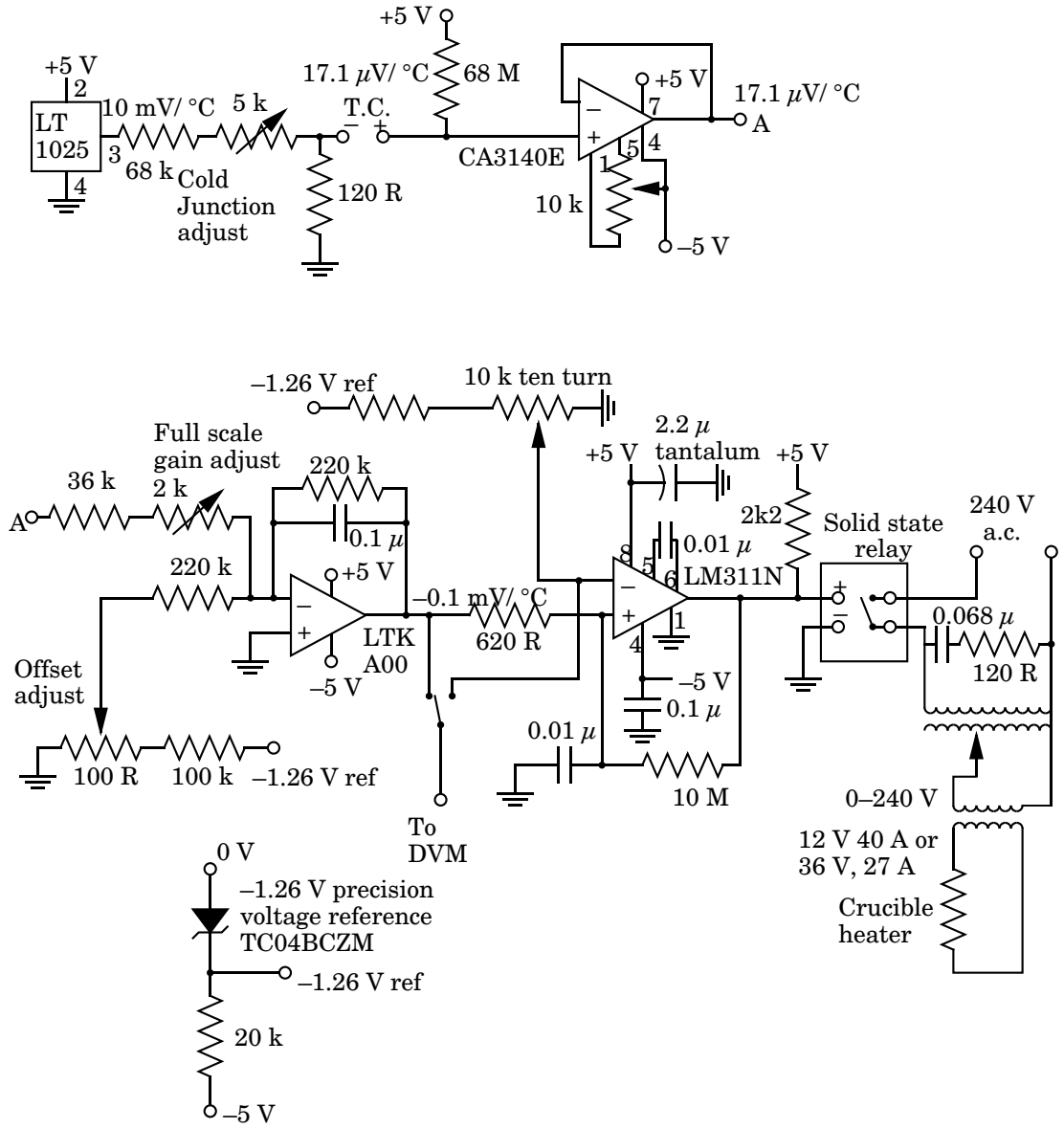


Figure A.3 Temperature controller

Appendix B

Abstracts of published papers

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CHEMICAL PHYSICS LETTERS

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Electron-stimulated ion–molecule reactions in O₂ films on graphite

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We have investigated the production of O⁻, O₂⁻ and O₃⁻ ions by electron-stimulated desorption from well-ordered films of physisorbed O₂ on graphite. Resonances observed in the yield of all products as a function of electron impact energy are attributed to dissociative electron attachment, generating O⁻ ions which can react with neighbouring O₂ molecules in the film. We interpret characteristic differences in the ion yield profiles from one product to another in terms of a simple binary collision model, which estimates the kinetic energy of the ion products and thus the probability of escape from the polarisation potential induced in the O₂ film. The model is also consistent with the measured angular distributions of desorbed ions.

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Electron-driven Dynamics at the Gas/Solid Interface: Dissociation, Desorption and Reaction of Adsorbed Molecules

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This paper considers dynamical processes which can be initiated by low-energy (1–50 eV) electrons in adsorbed molecular layers. We have investigated the production of negative ions by electron-stimulated desorption from well ordered monolayer and multilayer films of O₂ on graphite. Resonances are observed in the yield of both O⁻ and O₃⁻ ions, and are attributed to the process of dissociative electron attachment. In the monolayer regime, the 8 eV resonance which dominates the O⁻ yield at higher coverages is found to be suppressed, and dipolar dissociation dominates. This suppression is attributed to the image potential, which attracts low-energy ions back to the surface. The angular distribution of O⁻ ions desorbed from the monolayer δ and ζ phases we found to be almost independent of the initial molecular orientation on the surface. Classical trajectory calculations indicate that the molecule becomes rotationally excited prior to dissociation, causing the initial orientational order to be lost. This marks a difference between the dissociation and desorption dynamics of physisorbed and chemisorbed molecules, where the angular distribution of desorbed fragments is generally taken to reflect the molecular orientation on the surface.

Deposition and growth of noble metal clusters on graphite*

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The growth of silver and gold clusters following atomic vapour deposition on highly oriented pyrolytic graphite has been studied using scanning electron microscopy and scanning tunnelling microscopy (STM). Three-dimensional clusters were grown on the terraces and quasi-one-dimensional chains of clusters along the surface steps. An STM study was made on the effect of the step height on cluster nucleation. Charge-density modulations on the substrate surface around the silver clusters were analysed. A preliminary study of the deposition of mass-selected silver clusters from a beam onto the graphite surface has been made. The effect of the impact energy of silver clusters on the deposition process is explored.

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Experimental studies of surface modification and cluster deposition

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1. Introduction

Size-selected atomic clusters can be regarded as new building blocks for the fabrication of nanostructured materials [1]. This short paper will summarise our first experimental studies of the deposition and self-organisation of *mass-selected* metal clusters on surfaces as a function of cluster size, kinetic energy and deposition rate. We will focus on the case of Ag clusters, containing ~20-300 atoms, deposited on graphite. Such studies are essential for the future technological applications of atomic clusters.

Recent investigations of the deposition of C₆₀ clusters on surfaces present a challenge for the deposition of metal clusters. In the case of C₆₀, ordered monolayers can now be grown on a variety of substrates, even at room temperature [2,3]. The surface both organises and dopes the semiconducting C₆₀ layer. Multilayer structures, incorporating C₆₀ layers as well as layers of alkali metal dopants, have also been grown [4]. Because C₆₀ is a covalently bonded cluster (molecule), and the interaction between C₆₀ clusters is weak (Van der Waals), the integrity of the cluster is maintained in these layers. If we are to produce truly "cluster-assembled" films from metal clusters, then we have to explore the deposition conditions under which the integrity of the metal cluster is also retained on the surface.

Extended abstract for

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