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Preface

Synchrotron Radiation has revolutionized our ability to perform spectroscopy in the vacuum UV and X-ray regions, and crystallography both on metalloproteins and small molecule inorganic complexes.

Currently, 23 countries have or are building synchrotron radiation facilities. The overall layout of the Stanford Synchrotron Radiation Laboratories at the Stanford Linear Accelerator Center (Stanford, USA) is shown in Fig. 1. The Stanford Positron Electron Asymmetric Ring (SPEAR) is its light source. The SPEAR ring has been operating for 30 years, first as SPEAR1 at electron energies of ∼2.4 GeV and then as SPEAR2 with electron energies up to ∼3.0 GeV. It is being upgraded to SPEAR3, which is regarded as a third generation light source and will provide highly stable beam operating conditions with electron energies of 3.0 GeV, beam currents up to 500 mA, a long lifetime of ∼50 h and low emittance of 18 nm rad (versus 100 mA, ∼30 h, 160 nm rad in SPEAR 2). The focused photon flux will increase by an order of magnitude and the photon brightness will increase by approximately two orders of magnitude (there are more details on the SSRL website at: http://www-ssrl.slac.stanford.edu/spear3/INDEX.HTML), opening a wide range of new spectroscopic and structural handles for problems inorganic and bioinorganic chemistry.

A radiation facility is typically composed of a linear accelerator and a synchrotron/storage ring. Linear accelerators (Fig. 2) have been used as injectors for synchrotrons

Fig. 1. Aerial view of Stanford Linear Accelerator Center (SLAC) with Stanford Synchrotron Radiation Laboratories (SSRL) as ring in lower right corner. For scale note HWY 280 crossing the upper part of the figure and the linear accelerator (Linac) crossing under HYW 280. Courtesy of Stanford Linear Accelerator Center (Stanford, USA).

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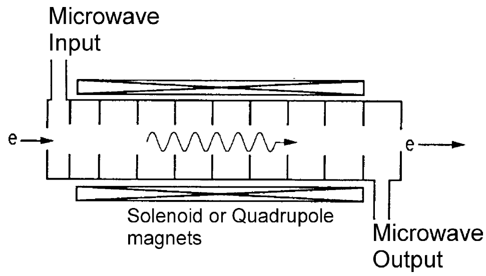

Fig. 2. Schematic of a linear accelerator. Adapted from Applications of Synchrotron Radiation to Materials Analysis. Eds. H. Saisho and Y. Gohshi. 1996 Elsevier Science B. V.

and storage rings. These consist of an electron gun (source), solenoid coils or quadrupole magnets for focusing electrons and microwave wave-guides for accelerating electrons. The synchrotron/storage ring (Fig. 3) is a circular magnetic accelerator, where the electron bunches are bent and focused using a time-dependent magnetic field and are accelerated by radio frequency cavities. The electron injection is at a lower (∼1/10) magnetic field and then the field strength is increased to accelerate the electrons.

Electrons move in a definite circular orbit and can be stored for several hours in the ring which is kept at ultra-high vacuum (10^{-9} to 10^{-10} Torr) to minimize energy loss due to collision and scattering with molecules. The electron beam is bent by dipole magnets placed along the orbit, and the magnetic field is held constant to keep the electron beam energy constant. The circulating electrons lose energy by emitting synchrotron radiation in the tangential direction. Radio frequency accelerating cavities are provided along the ring to make up for this energy loss.

Synchrotron facilities also have insertion devices usually in straight sections of the storage ring such as wigglers and undulators (Fig. 4), which are effective sources of radiation. The insertion device is a set of magnets with alternating polarity in the direction of motion of the electron beam. As a result, the electron trajectory follows a sinusoidal curve inside the insertion device. The radiation generated by the insertion devices has spectral properties (e.g., higher brightness) different from that obtained from bending magnets and as a result have various specialized applications. In general, the radiation is continuous from VUV to very hard X-rays (>100 KeV) and polarized in the plane of the ring.

The above features are general to all synchrotron studies. Specific aspects of the utility of synchrotron radiation for different types of experiments are described in detail in the following individual chapters. The topics covered in this volume span the range of the different applications of synchrotron radiation to problems in inorganic and bioinorganic chemistry. They are written by many of the leading experts in the field. It is hoped that this volume will both explain these applications to the broad inorganic community on a pedagogical level and, importantly, attract new researchers where specific methods can solve important problems in inorganic chemistry.

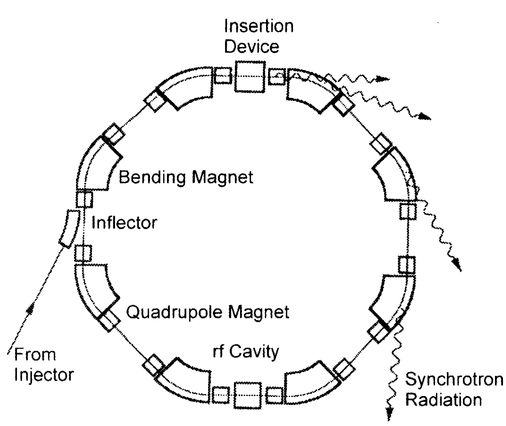

Fig. 3. Schematic of a synchrotron source. Adapted from Applications of Synchroton Radiation to Materials Analysis. Eds. H. Saisho and Y. Gohshi. 1996 Elsevier Science B.V.

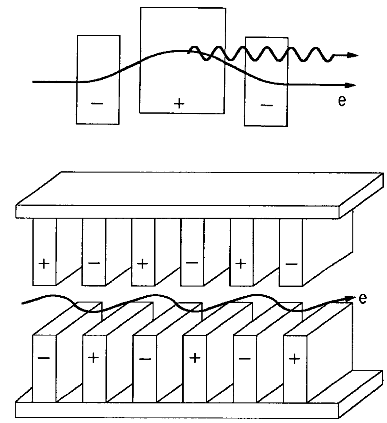

Fig. 4. Schematic of a wiggler (top) and an undulator (bottom). Adapted from Applications of Synchrotron Radiation to Materials Analysis. Eds. H. Saisho and Y. Gohshi. 1996 Elsevier Science B.V.

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