Synchrotron radiation

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Since 1970s, when the first synchrotron radiation (SR) facilities became available to condensed matter researchers, they greatly influenced the progress in determining the properties of materials. As synchrotron technology matured at 3rd generation machines like ESRF (France), APS (USA) and Spring-8 (Japan), the experimental techniques became more sophisticated and easier to implement. Nowadays, there are more than 50 light sources worldwide (operational, or under construction).

Extraordinary properties of SR – broad spectrum, high brilliance, small beamsize, short pulses, high coherence, teneable linear and circular polarization, etc. – are utilised by diversified experimental techniques to investigate the properties of matter [1,2]. The community of synchrotron radiation users, originally formed by solid state physicists and chemists, has soon extended to structural biologists and since the beginning of XXI century to (among others) archaeologists, environmental scientists, polymer chemists, biologists, art restoration experts, organic chemists and astrophysicists.

In my lecture I will present the basics of synchrotron physics, the methods of generation of the synchrotron light and the most extraordinary properties of SR. Followed by introduction to x-rays and their interaction with matter it will form a ground for understanding the principles of the most popular experimental techniques in SR laboratories, namely diffraction, resonant and non-resonant inelastic scattering, absorption, imaging, and tomography. All these techniques can also be applied to study magnetic properties of materials taking advantage of polarization-dependent absorption (dichroism) and dispersion (birefringence) [3-5].

I will present a review of selected experimental results in order to illustrate the capacity of SR in the study of magnetic properties with element, depth and site selectivity, at extreme conditions, and with nm and fs resolution. Pros and cons of SR probes with respect to other methods will be discussed. Finally, the potential for magnetic research at the emerging fourth generation SR sources (UV and X-ray free electron lasers) will be reviewed [6,7].

References

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