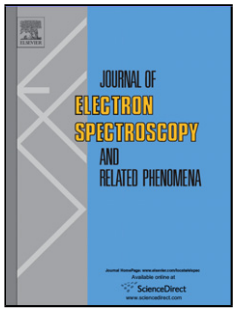

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Double core hole spectroscopy with synchrotron radiation

F. Penent[1,2*], M. Nakano[3,4], M. Tashiro[5], T. P. Grozdanov[6], M. Žitnik[7], K. Bučar[7], S. Carniato[1,2], P. Selles[1,2], L. Andric[1,2], P. Lablanquie[1,2], J. Palaudoux[1,2], E. Shigemasa[5], H. Iwayama[5], Y. Hikosaka[8], K. Soejima[8], I.H. Suzuki[3], N. Berrah[9], A. H. Wuosmaa[9], T. Kaneyasu[10] and K. Ito[3]

[1]*Sorbonne Université, UPMC, Université Paris 06, LCPMR, 11 rue P. et M. Curie, 75231 Paris Cedex 05, France.*

[2]*CNRS, LCPMR (UMR 7614), 11 rue P. et M. Curie, 75231 Paris Cedex 05, France.*

[3]*Photon Factory, Institute of Materials Structure Science, Oho, Tsukuba 305-0801, Japan.*

[4]*Department of Chemistry, Tokyo Institute of Technology, O-okayama, Tokyo 152-8551, Japan*

[5]*Institute for Molecular Science, Okazaki 444-8585, Japan.*

[6]*Institute of Physics, University of Belgrade, Pregrevica118, 11080 Belgrade, Serbia.*

[7]*Jožef Stefan Institute, P. O. Box 3000, SI-1001 Ljubljana, Slovenia.*

[8]*Department of Environmental Science, Niigata University, Niigata 950-2181, Japan*

[9]*University of Connecticut, Physics Department, , Storrs, CT 06269- USA*

[10] *SAGA Light Source, 8-7 Yayoigaoka, Tosu, Saga 841-0005, Japan*

*Corresponding author, email: francis.penent@upmc.fr

Summary: In the last five years, a strong experimental and theoretical activity has been dedicated to the study of inner-shell double photoionization. Almost simultaneously, between 2009 and 2011, different experiments were performed using two different light sources: well established third generation synchrotron light sources that exist for more than two decades and recently developed x-ray free electron lasers (X-FEL) that provide brightness about 10 orders of magnitude higher. The high photon flux of X-FEL has made possible the successive absorption of many x-ray photons by inner-shell electrons in femtosecond timescale. The possibility to create multiple inner-shell vacancies with this new X-FEL light source has resuscitated "prophetic" 25 years old calculations by Cederbaum et al. [1] [2] concerning double K-shell ionization that could be of great interest when conventional Electron Spectroscopy for Chemical Analysis (ESCA) finds some limitations. As a feedback, this has stimulated new theoretical developments. On the other hand, it was considered practically out of reach to observe such states with conventional third generation synchrotron light sources due to the very weak probability to eject two inner-shell electrons by a single photon when the dominant process, that could mask everything else, is single inner-shell ionization. However, due to the development of very efficient detection techniques, it was also possible to perform spectroscopy of double core-hole states with excellent accuracy using third generation synchrotron sources.

In this paper we give an outlook, on the basis of recently published results, of the complementary of these light sources for double core-hole spectroscopy. Some new developments and results are also presented with a prospective of what could be done in the future with the technical breakthrough that will be necessary to improve further our understanding of chemical analysis.

Introduction:

Since 2009, a great interest has been devoted to the study of double core-hole ionization of atoms and molecules in the gas phase using X-FEL and synchrotron light sources. Such studies