

Development of synchrotron vibrational spectromicroscopy for assessment of stress responses of human cells to low doses of environmental agents

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Abstract

Vibrational spectroscopy, when combined with synchrotron radiation-based (SR) microscopy, is a potentially powerful new analytical tool with high spatial resolution for detecting chemical changes in cellular nucleic acids and proteins. In contrast to other methods that measure either a certain type of DNA damage or a cellular response to a stressor, SR vibrational spectroscopic analysis provides a composite view of the molecular responses in individual cells. Observed spectral changes include all types of lesions induced in that cell as well as cellular responses to the stress. These spectral changes combined with other analytical tools may provide a fundamental understanding of the key molecular mechanisms induced in response to stresses created by low-dose environmental agents, such as radiation and selected chemicals.

In this study we used the high spatial-resolution SR FTIR vibrational spectromicroscopy as a sensitive analytical tool to detect chemical- and radiation-induced changes in individual human cells. Our preliminary spectral measurements indicate that this technique is sensitive enough to detect chemical changes in nucleic acids and proteins of cells treated with environmentally relevant concentrations of chemical pollutants like dioxin and polycyclic aromatic hydrocarbons. We see spectral changes in cells after treatment with low doses of 150 kVp x-rays. We also observed spectral changes that appear unique to each exogenous stressor and believe this technique has the potential to distinguish changes from exogenous or endogenous oxidative processes.

Acknowledgement: This work was supported by the Director, Office of Energy Research, Office of Science, Materials Sciences Division of the U.S. Department of Energy, under Contract No. DE-AC03-76SF00098.

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