FOGALE nanotech

Application Note

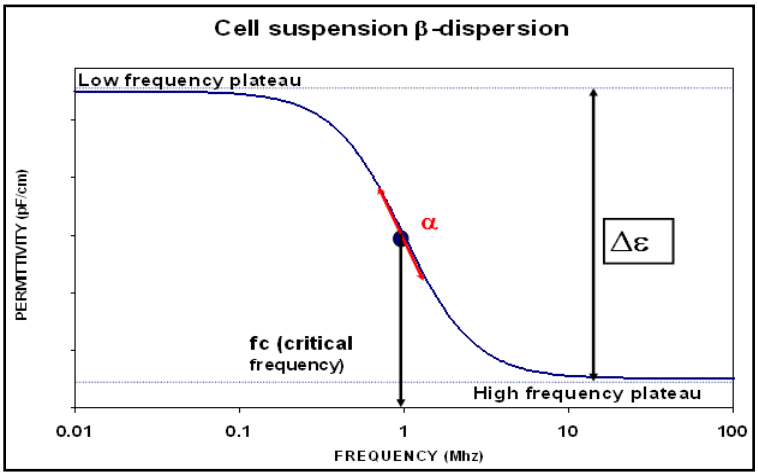
Online Dielectric Spectroscopy Measurement – How Does It Work?

Benefits

The spectroscopy module provides information related to the physiological state of the cells. It enables detailed characterization of the process dynamics, leading to a better understanding of the process and a better control of the process in its optimal operating range.
It can be used to monitor key phases of processes that are characterized by major physiological changes in the host cell population. It is specifically for cell culture and yeast applications as it is based on spherical model.

Principle

With this advanced spectroscopy module, the system measures the capacitance values at 17 different frequencies (from 0.3 to 10MHz) during a frequency scan. The module subsequently computes the resulting spectrum - called beta dispersion. This spectrum is mathematically defined by 3 key parameters (Δε, fc, α) that are functions of the biovolume, the cell intracellular conductivity, the cell membrane capacitance and the cell radius.
Δε, fc, and α, which are measured by the system, can therefore reflect changes in the cell physiology and morphology.



$$\Delta\varepsilon_{max} = \frac{9}{4}.P.r.Cm$$

$$fc = \frac{\sigma_i}{4.\pi.r.Cm}$$

α = cell population homogeneity

P = Biovolume (volume fraction ; r = cell radius ; Cm = membrane capacitance ; σi = intracellular conductivity

These spectroscopy signals can be used in different ways:
1- highlight important events in a culture. Example: the successful infection of sf9 insect cells is reflected by an inverted peak in the fc signal.
2- used as a reference signal to identify deviations in the process.
3- used to calculate 2 cell physiological parameters: Cm membrane capacitance and σi intracellular conductivity (Cm and σi can be calculated with the biomass system measurements + offline cell radius measurements)
4- used in statistical models.

References

On-line viable cell density and physiological states monitoring by dielectric spectroscopy sf9 growth and infection process. G.Esteban. CCEX 2006 Poster.
On-line monitoring of infected Sf-9 insect cell cultures by scanning permittivity measurements and comparison with off-line biovolume measurements. Sven Ansorge. Cytotechnology (2007) 55:115–124
Process optimization of large-scale production of recombinant adeno-associated vectors using dielectric spectroscopy. Alejandro Negrete. Appl Microbiol Biotechnol (2007) 76:761–772.
Capacitance Sensor as a Robust Tool for Cell Culture Monitoring in Process Development and Manufacturing. Damien Voisard. Biochemical Engineering XV 2007 Poster; CCE XI 2008 Poster
Quantitative Modeling of Viable Cell Density, Cell Size, Intracellular Conductivity, and Membrane Capacitance in Batch and Fed-Batch CHO Processes Using Dielectric Spectroscopy. Cary Opel. Biotechnolog. Prog. (2010) Vol 26 No. 4
On-Line Monitoring of Lentiviral Vector Production for Characterization of Viral Production and Release Kinetics. Sven Ansorge. ESACT 2009 Poster