

# BARRIER PERFORMANCE MODELING

## M-Rule predictive modeling – 4 levels of simulation

- **OTR** – oxygen transfer rate
  - Empty-bottle calculation, container only
- **O<sub>2</sub> ingress** – cumulative oxygen transfer, normalized to product weight
  - Empty-bottle calculation, container or container + cap
- **Oxysense simulation** – oxygen concentration (dissolved)
  - Filled/capped container calculation
  - Nonreactive medium (water), zero headspace (usually)
  - Precise high- or low-oxygen initial condition, chosen per barrier type
- **Product simulation** – oxygen concentration, vitamin/antiox levels
  - Filled/capped container with headspace
  - Reactive fill medium w/solutes, some initial oxygen
  - Highly variable oxidizable content, oxidation rates

Most direct container comparison

Increasing relevance to shelf life  
(and complexity)