

# Multiscale Structural Features of Low-Methoxyl Pectin Solution and Calcium-Induced Gel

Peng-Ju Lin (林芄汝), Chien-You Su (蘇建又), Ssu-Ting Huang (黃思婷), and Chi-Chung Hua (華繼中)\*

Department of Chemical Engineering, National Chung Cheng University, Chiayi, Taiwan  
[chmcch@ccu.edu.tw](mailto:chmcch@ccu.edu.tw)

## Abstract

Multiscale structural features of pure (low-methoxyl) pectin solutions and a representative pectin/calcium sol-gel system were systematically explored using combined (dynamic/static) light/X-ray scattering characterizations. Pure pectin solutions in both dilute and semidilute regimes were revealed by dynamic light scattering (DLS) analysis to be composed of nearly monodisperse micrometer-sized clusters. When a critical amount of calcium (10 wt%) was added to a semidilute pectin solution (2 wt%), the system was observed to turn into gel after ~4 h at ambient conditions. The DLS analysis revealed a single elastic relaxation mode for the initial sol state, as well as two newly emerging short-time elastic modes during the subsequent sol-gel transition. Combined light/X-ray (static) scattering analyses corroborated that the above-mentioned elastic attributes of DLS relaxation modes represent an interior reorganization process within the cluster species, which were in a jammed state upon the addition of calcium. The role played by calcium was further revealed to trigger the formation of hierarchical structures within a typical pectin cluster, propagating from the nanometer-sized packing units to mesoscale spherical aggregates (~ 200 in radius of gyration) which, in turn, constitute the micrometer-sized cluster species. This study indicates that the structural features of pectin solution, sol, and gel—which control the mechanical properties of pectin in most practical applications—are richer than previously known, while early studies explored mainly the local and fine structural features that are complementary to the present findings.

**Keywords – Optical Scattering; Pectin Solution; Pectin–Calcium Gel**