The Rheological Behavior of Collagen Solutions Cross-linked by Series of Oxidized Dextran

Zhimian Zhu, Lihong Fu, Wei Kuang, Donglei Liu, Xin Wang, Huilin Tian* *

1. (Qilu University of Technology(Shandong Academy of Sciences), School of Light Science and Engineering, Jinan, Shandong 250353, China)

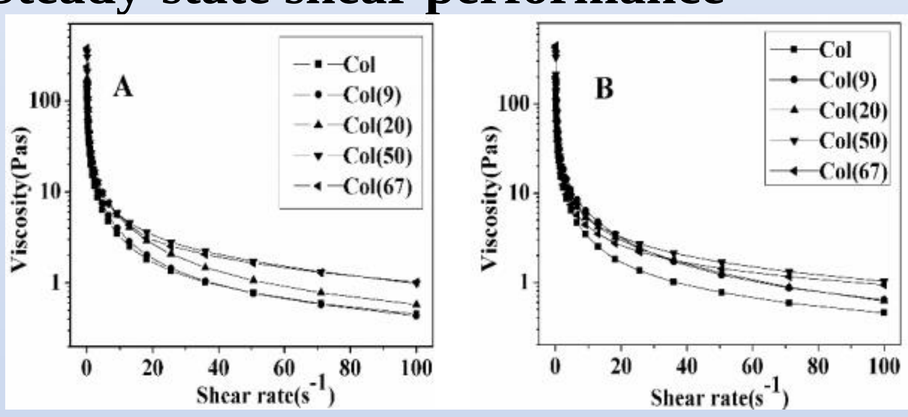
2. Key Laboratory for Green Technology of Leather Manufacture, China National Light Industry Council

Introduction

- Nowadays collagen-based scaffold materials are widely used for tissue engineering because of their many advantages, including lack of antigenicity, abundant availability, bioresorbability and biocompatibility. Since the collagen products are produced by collagen solutions and the mechanical handlings could influence their properties. Therefore understanding the rheological behavior of collagen solutions is of vital importance.
- In this study, the rheological behavior of collagen solutions crosslinked by oxidized dextran T_{70}, oxidized dextran T_{200} (referred to as $ODex_{70}$, $ODex_{200}$) is carried on through steady-state shear performance, dynamic viscoelasticity and thixotropy test.

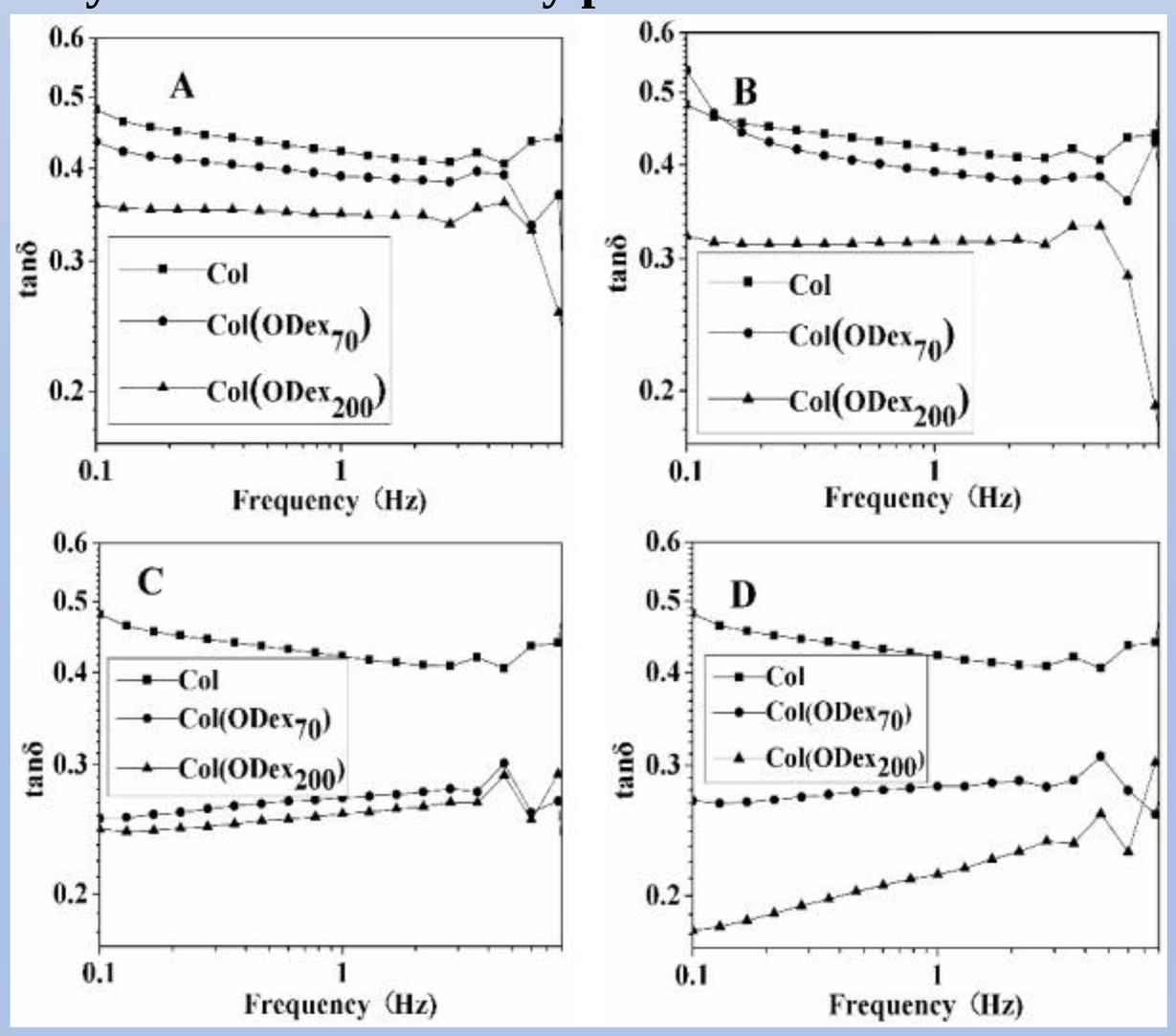
Results and Discussion

1. Steady-state shear performance



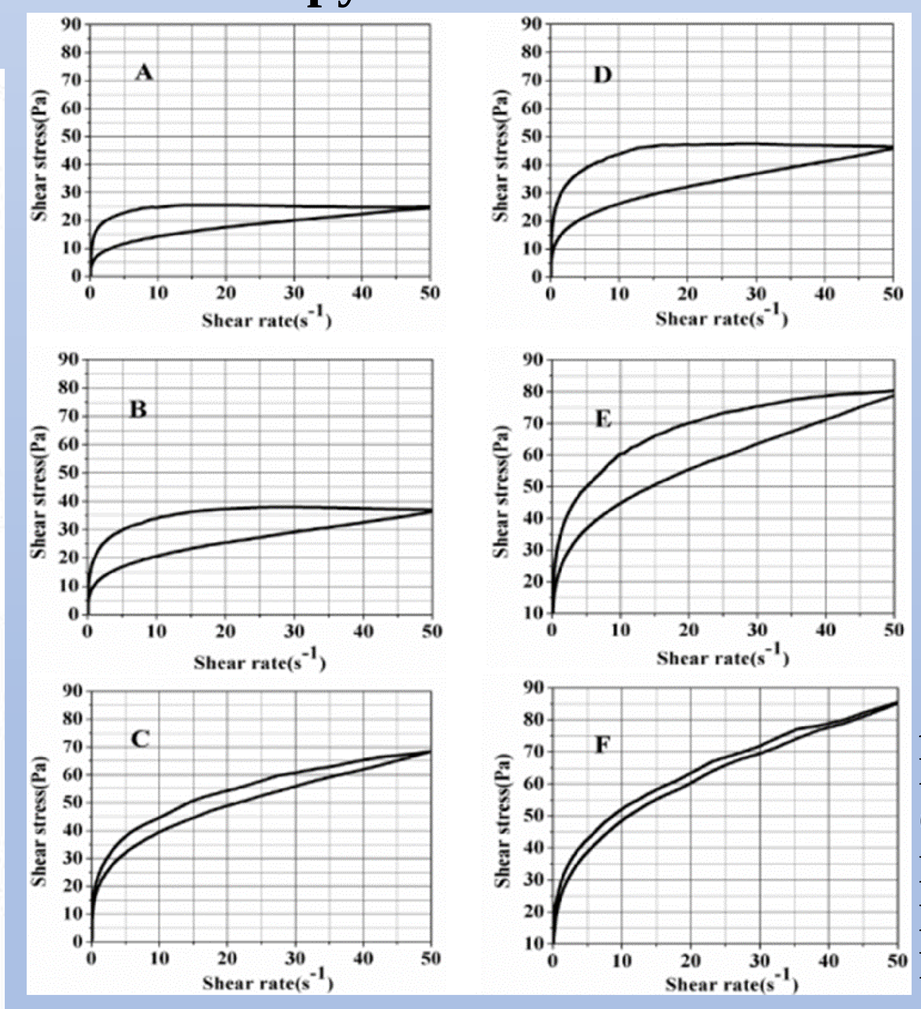
- All the modified collagen samples exhibited typical "shear thinning" behavior.
- The viscosity of the $ODex_{70}$-modified collagen solution was less than that of $ODex_{200}$-modified collagen solution at the same ODex dosage, indicating that $ODex_{200}$ had a good cross-linking effect.

2. Dynamic viscoelasticity performance



- The elastic modulus of modified collagen solutions were larger than the viscous modulus, reflecting gel-like property.
- The gel-like property becomes stronger with the increase of $ODex_{70}$ and $ODex_{200}$.
- tan δ (pure collagen)>tan δ ($ODex_{70}$)>tan δ ($ODex_{200}$), indicating that $ODex_{200}$ cross-linking effect was better.

3. Thixotropy test



A. Col/$ODex_{70}$ 10：1；
B.Col/$ODex_{70}$ 8：2；
C .Col/$ODex_{70}$ 5：5；
D.Col/$ODex_{200}$ 10：1；
E .Col/$ODex_{200}$ 8：2；
F.Col/$ODex_{200}$ 5：5

- the area of the thixotropy ring first increased and then decreased with the increase of the $ODex_{70}$ and $ODex_{200}$ which was related to the stability of the solution.
- With the increase of the amount of $ODex_{70}$, and $ODex_{200}$ the energy required to destroy the structure of the material was larger and the area of the thixotropic ring became larger accordingly. Therefore under the action of shearing, the modified collagen aggregation state was resistant to shear and recovers quickly.