



**AALBORG UNIVERSITY**  
DENMARK

**Aalborg Universitet**

## **Tough Double Interpenetrating Network Hydrogel with Dual Reinforcement Mechanism**

Fan, Wei; Jensen, Lars Rosgaard; Yu, Donghong; Smedskjær, Morten Mattrup

*Publication date:*  
2021

*Document Version*  
Other version

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Fan, W., Jensen, L. R., Yu, D., & Smedskjær, M. M. (2021). *Tough Double Interpenetrating Network Hydrogel with Dual Reinforcement Mechanism*. Poster presented at 14th Pacific Rim Conference on Ceramic and Glass Technology, Vancouver, Canada.

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

### **Take down policy**

If you believe that this document breaches copyright please contact us at [vbn@aub.aau.dk](mailto:vbn@aub.aau.dk) providing details, and we will remove access to the work immediately and investigate your claim.

# **Tough Double Interpenetrating Network Hydrogel with Dual Reinforcement Mechanism**

Wei Fan<sup>1</sup>, Lars R. Jensen<sup>2</sup>, Donghong Yu<sup>1,\*</sup>, Morten M. Smedskjaer<sup>1,\*</sup>

<sup>1</sup> *Department of Chemistry and Bioscience, Aalborg University, 9220 Aalborg, Denmark*

<sup>2</sup> *Department of Materials and Production, Aalborg University, 9220 Aalborg, Denmark*

\* *Corresponding authors. e-mail: [yu@bio.aau.dk](mailto:yu@bio.aau.dk) (D.Y.), [mos@bio.aau.dk](mailto:mos@bio.aau.dk) (M.M.S.)*

Tough hydrogels, containing 3D cross-linked polymer networks and large amount of water, are highly rated for their wide applications in bioengineering, soft robotics and agriculture. Double interpenetrating networks show extraordinary toughness compared with single ones. Alginate, as a natural anionic polymer with advantages such as biocompatibility, low toxicity and low cost, could potentially be applied in biomedical applications. Ionic crosslinking methods with divalent cations (e.g.,  $\text{Ca}^{2+}$ ) is the most common route to prepare alginate hydrogels under mild conditions. In this work, we mixed hydrophilic polyacrylic acid (PAA) and alginate hydrogel to form a tough double interpenetrating network (DIPN) structure. In order to improve the toughness of the hydrogel,  $\text{SiO}_2$  was added and in this way, we successfully achieved toughen DIPN hydrogel with ionic crosslinking and nanocomposites toughening mechanism simultaneously. We have systematically the impact of the amount of  $\text{Ca}^{2+}$  and  $\text{SiO}_2$  in the hydrogel on the mechanical performances. Compared with PAA hydrogel with elongation of 240% and stress to failure at 0.36 MPa, we obtained a alginate ( $\text{Ca}^{2+}$ )-PAA ( $\text{SiO}_2$ ) hydrogel with elongation of 1100% and stress to failure at 0.80 MPa. Our work paves the way for the construction of tough hydrogels with multiple reinforcement methods, with potential applications of biocompatible hydrogels into drug delivery and tissue engineering.