Phenylalanine-Based Low-Molecular-Weight Gelators: Synthesis, Supramolecular Characterization and Multicomponent Gelation

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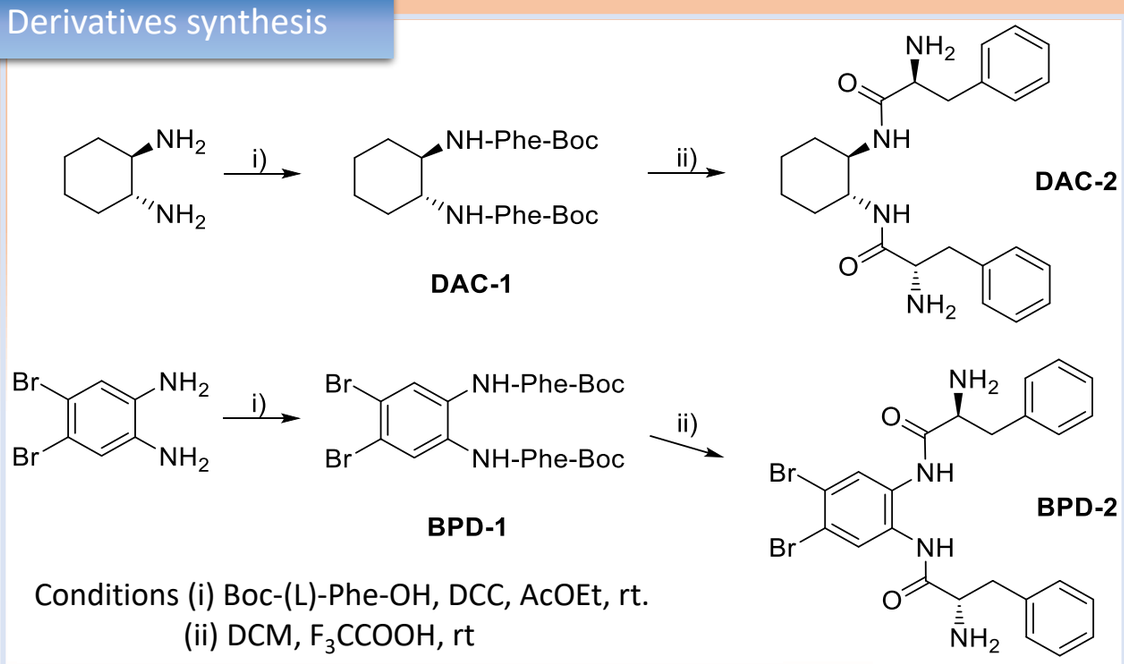
INTRODUCTION & AIM

L-Phenylalanine (Phe), a neutral and nonpolar essential amino acid, serves as a key building block for supramolecular assemblies. Several low-molecular-weight gelators (LMWGs) containing Phe have been developed, with potential applications in different areas such as drug delivery, tissue engineering, and oil spill recovery.[1] Similarly, vicinal dialkylamides have also demonstrated LMWG-forming capabilities, being promising materials for future research and development.[2]

In this context, the study of potential gelators was carried out with the synthesis of four Phe derivatives using 4,5-bromo-1,2-phenylenediamine (BPD) or (1R,2R)-(−)-1,2-diaminocyclohexane (DAC) as scaffolds.

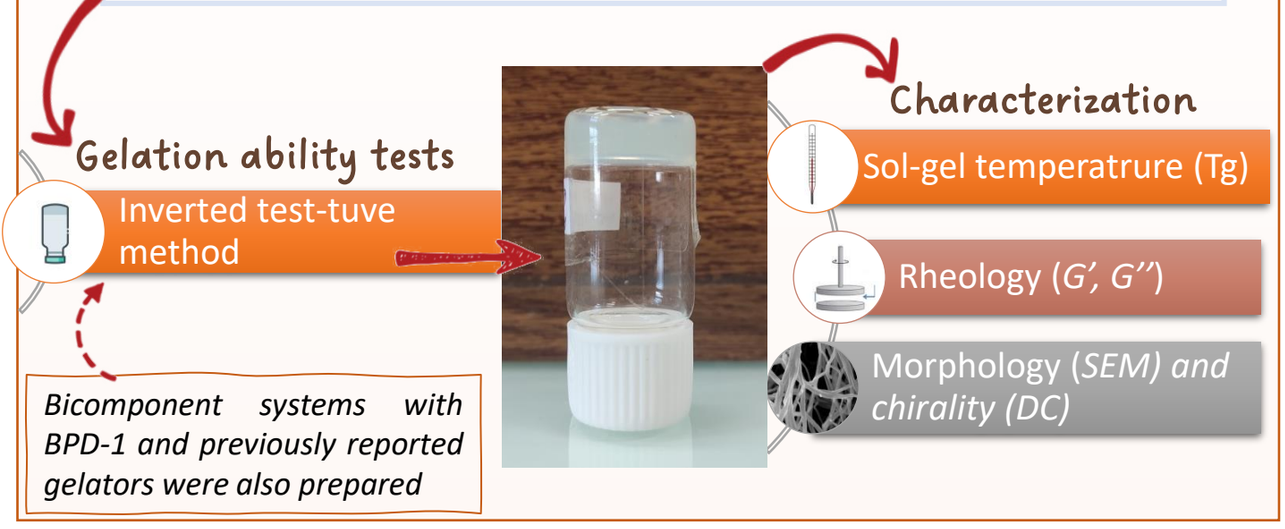
METHOD

Derivatives synthesis



Conditions (i) Boc-(L)-Phe-OH, DCC, AcOEt, rt.
(ii) DCM, F_3CCOOH, rt

Figuren 1. Reaction scheme of four Phe derivatives



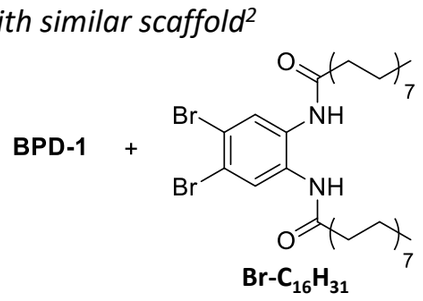
RESULTS & DISCUSSION

BPD-1 was found to produce stable gels in carbon tetrachloride, whereas DAC-2 generated an unstable gel in tetrahydrofuran

Compound	Solvent	Gel‡	T_g* (°C)	MGC† (mM)
DAC-2	THF	G	62	50
BPD-1	CCl_4	G	53	4,2
M-1	CCl_4	G	46	12

Table 1. Gelification tests results. ‡G: transparent gel. *Tg at 15 mM except for DAC-2 (60 mM). †Minimum gelation concentration

Bicomponent gel M-1: *an equimolar mixture of BPD-1 and a prevously reported gelator for CCl_4 with similar scaffold*[2]



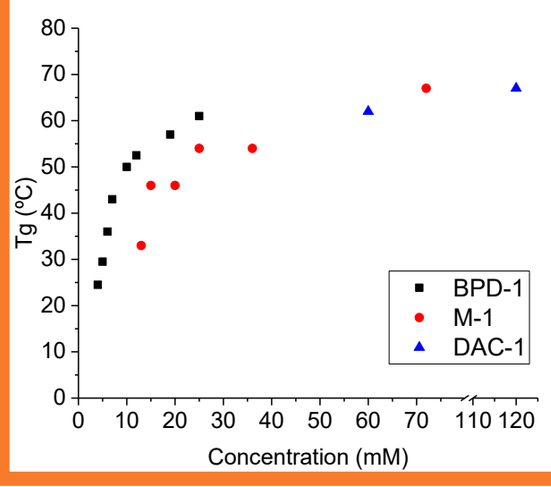


Figura 2. Tg as function of concentration. BPD-1 has a higher Tg than M-1 at equivalent concentrations. For DAC-1, Tg was only measurable in a few cases

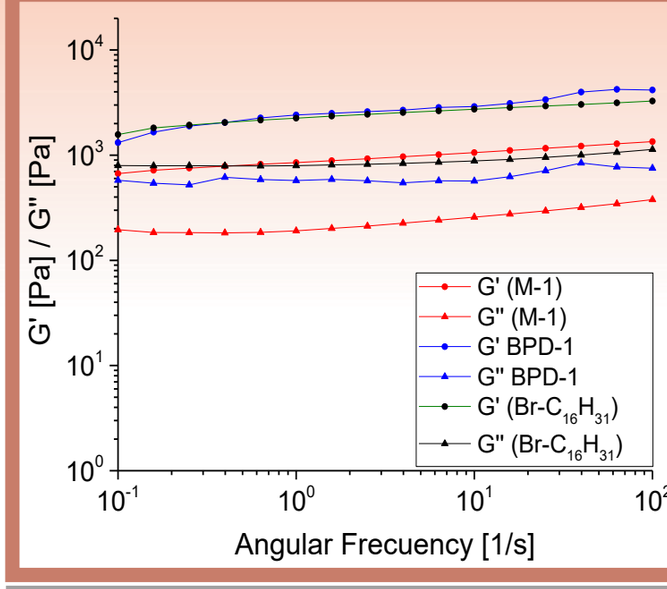


Figure 3. Storage modulus(G') and loss modulus (G") as functions of frecuency at 1% strain.

BPD-1 samples exhibithed typical gel behavior (G'>G"). While both pure gels BPD-1 and Br-$C_{16}H_{31}$ present similar mechanical properties, bicomponent M-1 system exhibits lower mechanical performance

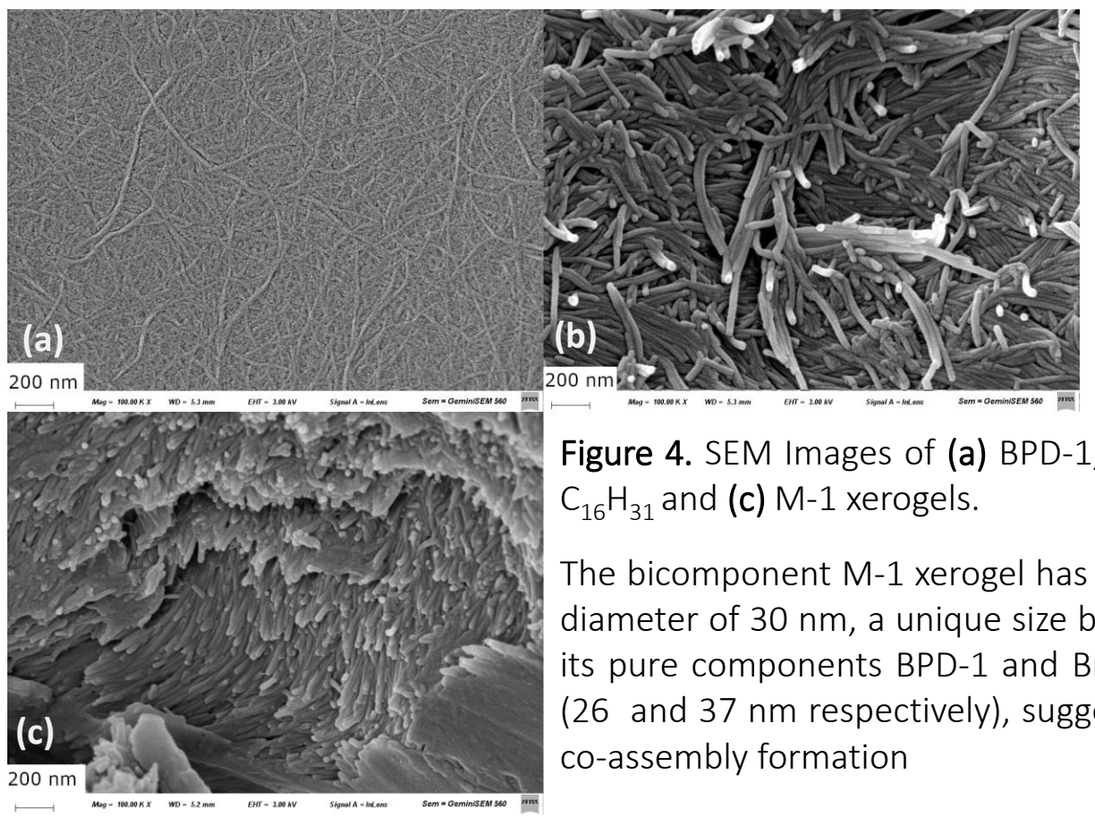


Figure 4. SEM Images of **(a)** BPD-1, **(b)** Br-$C_{16}H_{31}$ and **(c)** M-1 xerogels.

The bicomponent M-1 xerogel has a mean diameter of 30 nm, a unique size between its pure components BPD-1 and Br-$C_{16}H_{31}$ (26 and 37 nm respectively), suggesting a co-assembly formation

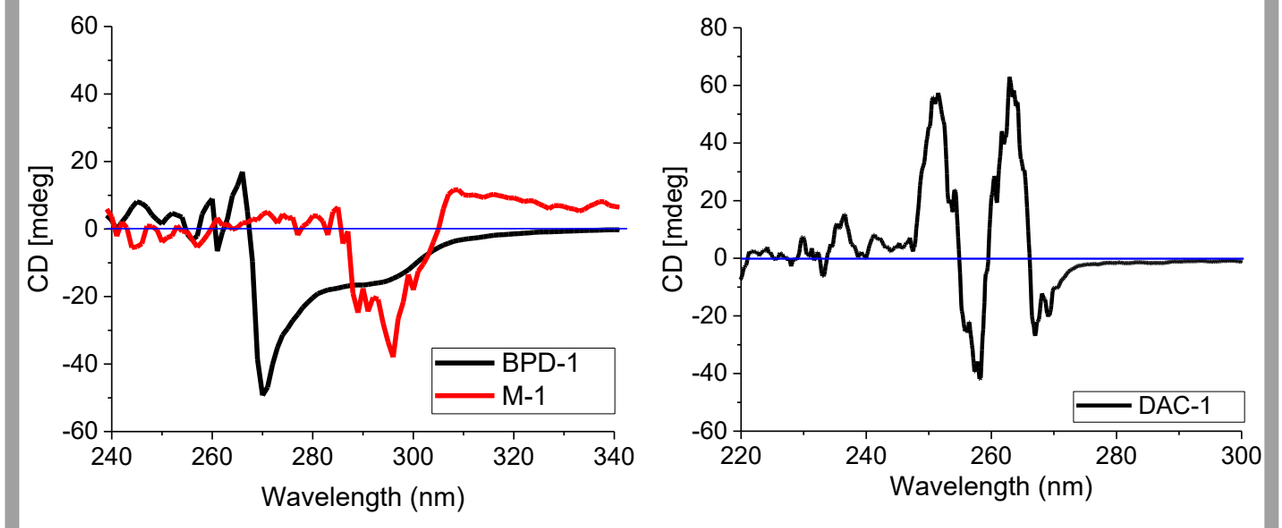


Figure 5. CD spectras of **(a)** BPD-1 pure gel and M-1, **(b)** DAC-1. The non-zero circular dichroism signals observed for all systems confirm their chirality

CONCLUSIONS

- L-Phenylalanine based gelator BPD-1 can form stable physical gels by its own but also multicomponent gels with a structurally related gelator through a co-assembly process mediated by amide hydrogen bonds
- Combining L-Phenylalanine with known LMWG fragments can yield new gelating derivatives
- Further studies should explore gelation in solvent mixtures and acidic aqueous medium

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2. Mac Cormak, A.S.; Busch, V.M.; Japas, M.L.; Giovanetti, L.; Di Salvo, F.; Di Chenna, P. H.M., *New Journal of Chemistry*, **2020**, 20, 8198-8208

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