

### Mechanical and electrochemical performances of clathrate hydrate-clay nanocomposite

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Among the various types of ionic clathrate hydrates,  $\text{Me}_4\text{NOH}\cdot 5\text{H}_2\text{O}$  has increasingly attracted interest as a potential proton conductor owing to both relatively high conductivity and high melting temperature. Despite these good performances even at low temperature, relatively poor mechanical properties of  $\text{Me}_4\text{NOH}\cdot 5\text{H}_2\text{O}$  limit its applicability and also lead to difficulties in preparing electrochemical devices where complicated elements are stacked with the conductor. Accordingly, we prepared a clathrate  $\text{Me}_4\text{NOH}\cdot 5\text{H}_2\text{O}$  nanocomposite incorporating clay particles to improve its mechanical properties. It was found that clay loading induced an increase of compressive strength from 7.78 MPa for pristine clathrate to 16.41 MPa for 2 wt % clay nanocomposite. This improvement could be attributed to good compatibility between the clathrate hydrate matrix and clay particles, and dispersion of the clay into the matrix on a nano-meter scale. In addition, we checked the proton conductivity and potential window of the nanocomposite in order to confirm that they are sufficient for real applications.