고체산화물 연료전지 단위전지의 제작을 위한 테이프캐스팅 슬러리의 바인더 및 분말 함량 비율 변화에 따른 유변학적 성질

The effects of binder content and solid loading ratio of tape cast slurry on rheological properties for the fabrication of single cells of solid oxide fuel cell (SOFC)

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Abstract

Solid oxide fuel cell (SOFC) is an energy conversion device which can generate electricity from chemical energy of hydrogen. For commercialization of SOFCs, reduction of manufacturing cost is required. Tape casting is one of the manufacturing processes for low cost manufacturing of single cells of SOFC, and hence it is widely used for commercial single cell fabrication. For tape casting, characteristics of tape cast slurry is the most important variable, and it has to be optimized. Rheological properties have an influence on fluid behavior of tape cast slurry during the casting step, which determines uniformity of final green tapes. These properties significantly depend on solid loading and binder contents of slurry. In this study, the effects of binder content and solid loading ratio of tape cast slurry on rheological properties for the fabrication of single cells of solid oxide fuel cell (SOFC).

Introduction

▪ Solid Oxide Fuel Cell (SOFC)

- High energy conversion efficiency ➔ Solution for energy issue
- High manufacturing cost ➔ Low cost manufacturing process required

▪ Tape casting process

- Simple and continuous fabrication method for SOFCs
- Co-sintering of anode and electrolyte layer

➔ **Cost-effective, Reduced sintering time, Mass production**

▪ Rheological properties of tape cast slurry

- Basic step: Casting of tape cast slurry for fabricating of green tapes
- Significant effects of rheological properties of the slurry on green tapes
- Binder content and solid loading: Most effective variables influencing rheological properties of tape cast slurry

➔ **Study on rheological properties with different binder content and solid loading required**

Experimental

▪ Fabrication of anode green tapes by tape casting

− NiO (AS graded, Kceracell, Republic of Korea), YSZ (TZ-8Y, TOSOH, Japan) powder were used with dispersant of triton, plasticizer of benzyl butyl phthalate (BBP, Santizier 160, Monsanto Co., USA) and polyethylene glycol (PEG, Sigma Aldrich), and Binder of polyvinyl butyral 79 (PVB 79, Butvar)

− Anode tapes with 500μn were formed by tape casting

▪ Evaluation of rheological properties of tape cast slurry

− A parallel-plate with a diameter of 25 mm was used with a gap distance of 1mm

− Changes of rheological properties depending on shear rate were examined by steady-state test

− Changes in dynamic properties were tested by oscillation stress amplitude sweep

▪ Evaluation of mechanical properties of green tapes

− The specimen were prepared with a dimension of 50 X 10 X 0.29 ± 0.03 mm^3

− The elongation rate was maintained at 2 mm min^{-1}

Conclusion

- Improved particle network strength was obtained by increased binder content and solid loading
- Improved tensile strength, but lower uniformity of green tapes was observed
- Improved packing density of green tapes was confirmed

Result

▪ Solid loading and binder content depending on solvent ratio

− Tape cast slurry was prepared as shown in Table.

− Solid loading and binder content were controlled by amount of solvent ratio

Solvent ratio [wt%]	Solid loading [wt%]	Binder content [wt%]
34	54	5.4
29	58	5.8
26	60	6.1
22	63	6.4
18	67	6.7

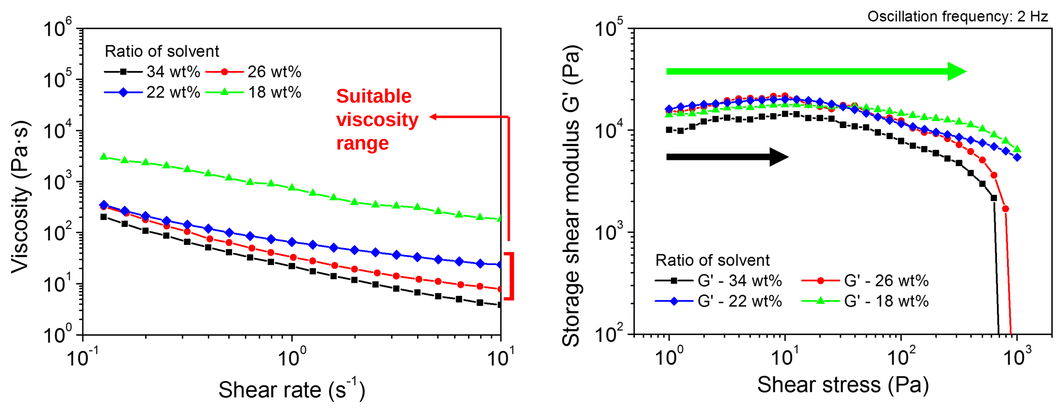
▪ Rheological properties of tape cast slurry

− Viscosity was increased as binder content and solid loading increased

− However, suitable viscosity range was limited to solvent ratio of 22-26 wt%

− Length of linear viscoelastic region (LVR) increased as binder content and solid loading increased

− Longer LVR was considered as improved particle network strength

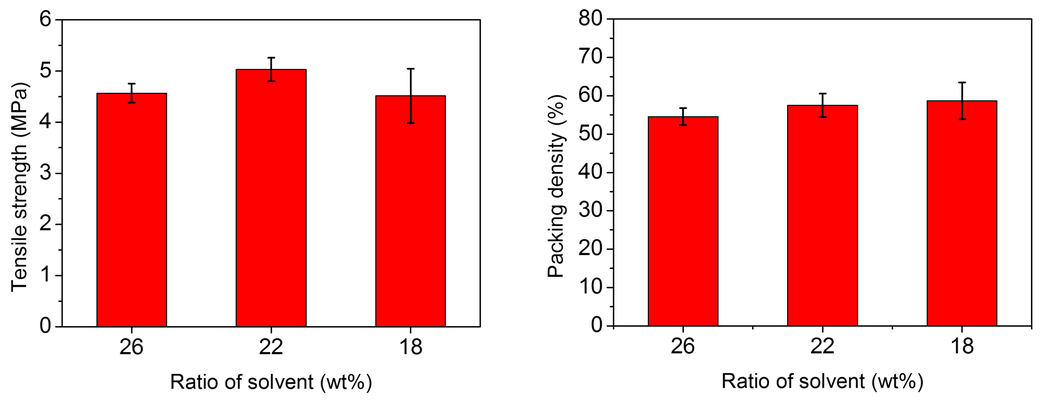


▪ Mechanical properties of green tapes

− Higher tensile strength was obtained with higher solid loading and binder content

− However, lower tensile strength with worse uniformity was observed at solvent ratio of 18 wt%

− Packing density was improved as solid loading and binder content increased



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