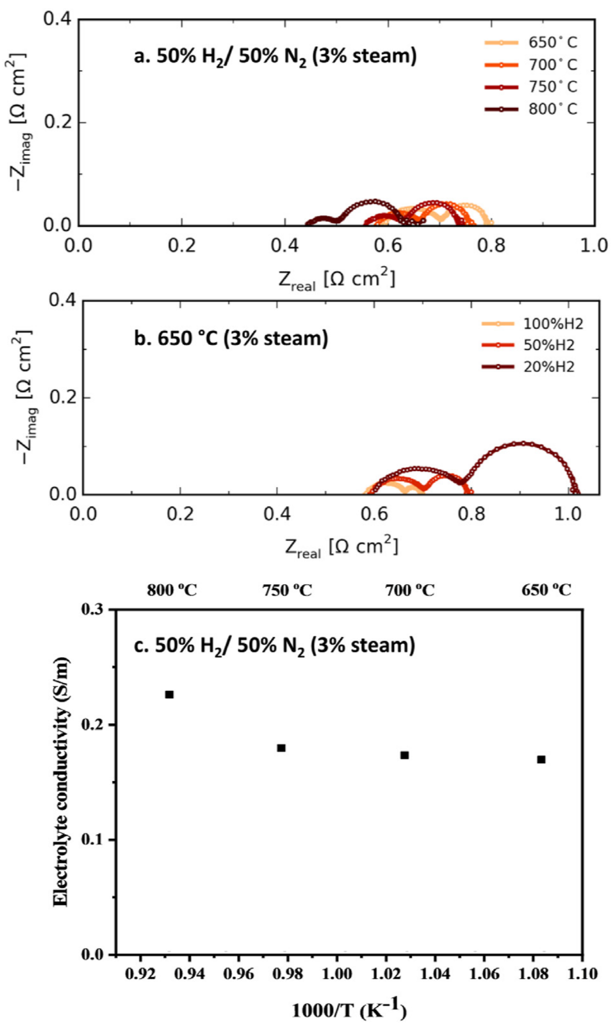

Fig. 5 – Nyquist plots of EIS data recorded on symmetrical cells at OCV and different temperatures (650–800 °C) under humidified (3% H_2O) 50% H_2/50%/N_2 (a.) and at 650 °C with varying hydrogen partial pressure (b.). Corresponding electrolyte conductivity under humidified (3% H_2O) 50% H_2/50% N_2 (c.).

work, BCZY27–Ni | BCZY27 | BCZY27–Ni protonic membranes exhibited R_s values of 0.59 and 0.44 Ω cm^2 at 650 and 800 °C (in 50% H_2/50% N_2, 3% H_2O). R_p values of 0.10 and 0.09 Ω cm^2 (per one electrode) were recorded in similar testing conditions. Comparable performances were recorded by other research groups with $BaZr_{0.8}Y_{0.2}O_{3-\delta}$ (BZY20), $BaCe_{0.7}Zr_{0.1}Y_{0.1}Yb_{0.1}O_{3-\delta}$ (BCZYYb), and $BaCe_{0.8}Zr_{0.1}Y_{0.1}O_{3-\delta}$ (BCZY811) symmetrical cells, as shown in Table 2.

Fig. 6 presents the durability measurement over 400 h on a symmetric cell tested at 650 °C in humidified (3% H_2O) 50% H_2/50% N_2 atmosphere, with negligible changes in the ohmic and polarization resistances. Therefore, this test highlights the good stability of the cell over 400 h. Based on these values, hydrogen fluxes of above 5 ml/cm^2/min can be expected, depending on the applied overpotential. Considering the large cell size and the possible compact design in a planar configuration, several applications related to hydrogen production can be envisioned. The extraction from pure hydrogen from diluted sources, steam methane (CH_4) reforming on a small scale, e.g. for hydrogen refueling stations, or the onboard production of hydrogen from liquid fuels in mobile applications (shipping, trucks, or fuel cell powered cars) have been identified as areas of interests, and will be pursued in the future.

In this study, BCZY27-based symmetrical protonic membranes were prepared and up-scaled to 135 cm^2. The cells were characterized microstructurally, mechanically and electrochemically. At first, the cells were microstructurally unstable due to hydration of the BCZY phase leading to chemical expansion of the electrolyte upon water uptake. However, this challenge was solved by reducing the cells soon after sintering, and large-size symmetrical cells could be prepared. The fracture toughness of BCZY27–Ni supports was assessed for the first time, corresponding to 2.07 (SD 0.05) MPa $m^{1/2}$. The electrochemical tests showed reasonable and stable performances in terms of ohmic and polarization resistances. In future works, the hydrogen permeation flux will be evaluated.

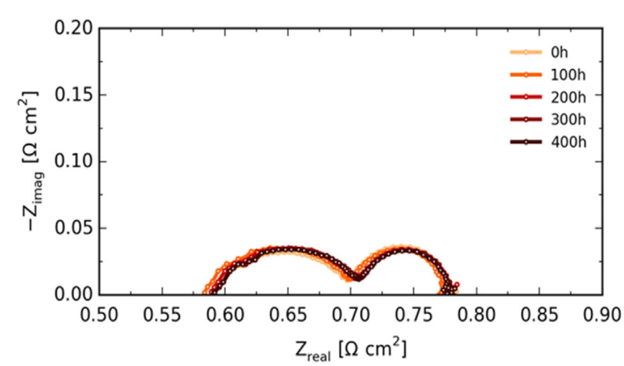

Fig. 6 – Nyquist plots recorded at 650 °C in humidified (3% H_2O) 50% H_2/50% N_2 atmosphere for 400 h.

Table 2 – Electrochemical performance of symmetrical PCC cells.

Electrolyte		Electrode	Gas composition	Temperature (°C)	R_s (Ω*cm^2)	R_p (Ω*cm^2)	Reference
Composition	Thickness (μm)						
BCZY27	13	BCZY27-Ni	50% H_2/50% N_2, 3% H_2O	650	0.59	0.10	This work
				800	0.44	0.09	
BZY20	20	BZY-Ni	100% H_2, 3% H_2O	600	0.57	0.14	[55]
BCZY811	40	BCZY811-Ni	20% H_2/80% Ar,	600	1.57	0.47	[56]
BCZYYb	60	BCZYYb	50% H_2/50% N_2, 3% H_2O	600	0.30	0.08	[57]