Solutocapillary Transport of Oxygen Bubbles in Diffusion-Bubbling Membrane Core

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Reactor

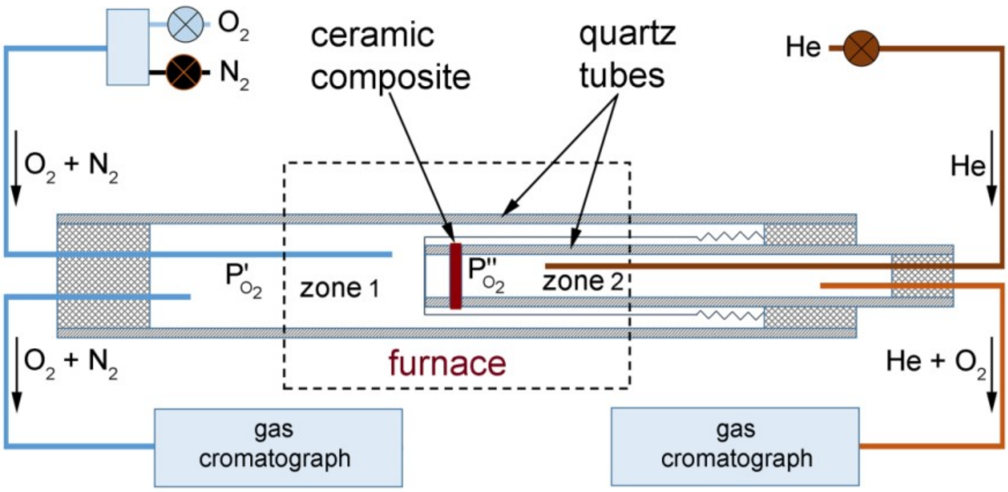
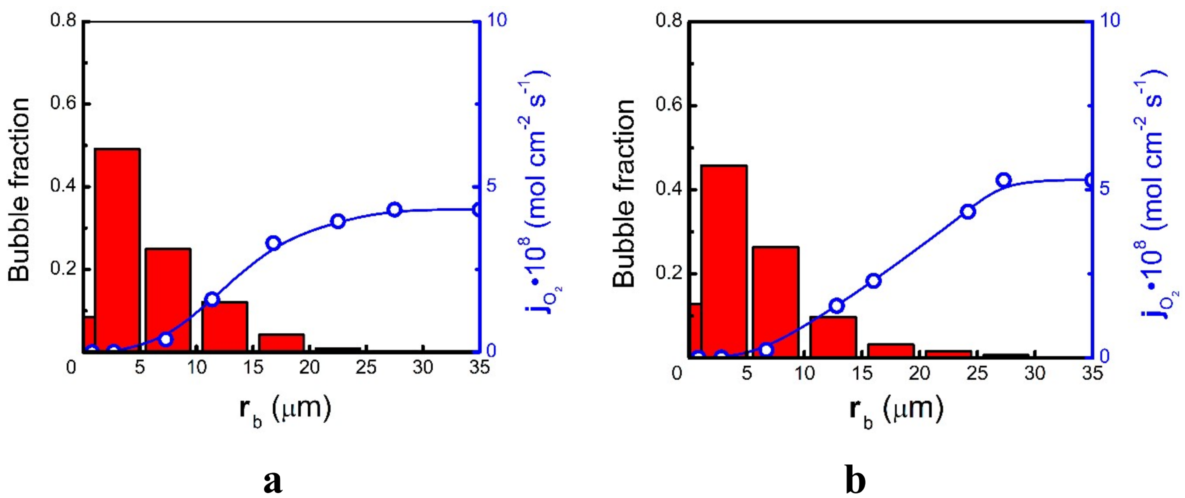
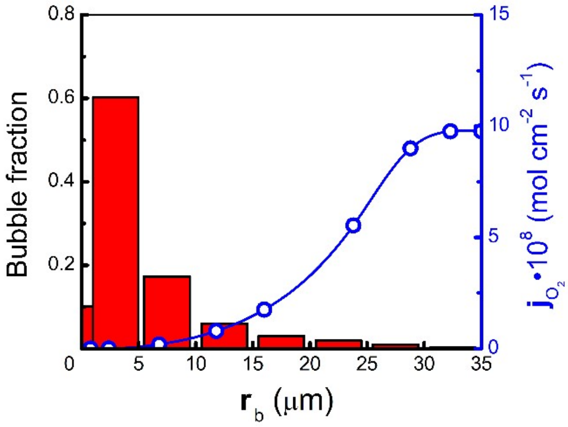


Figure S1. Schematic of experimental facility for thermal treatment of initial CuO - 25 wt % $Cu_5V_2O_{10}$ ceramic composite at 830 °C under an oxygen partial pressure difference [1].

Bubble size distribution and bubble density





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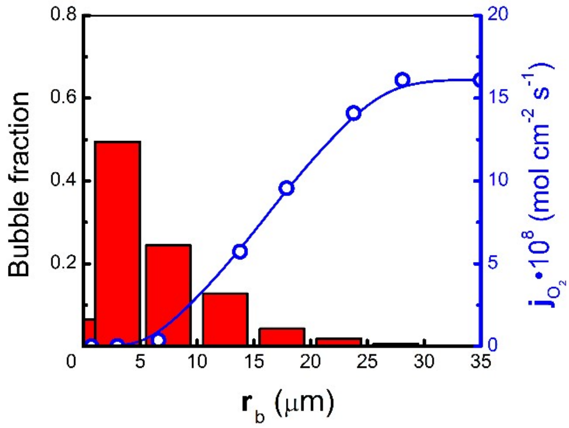

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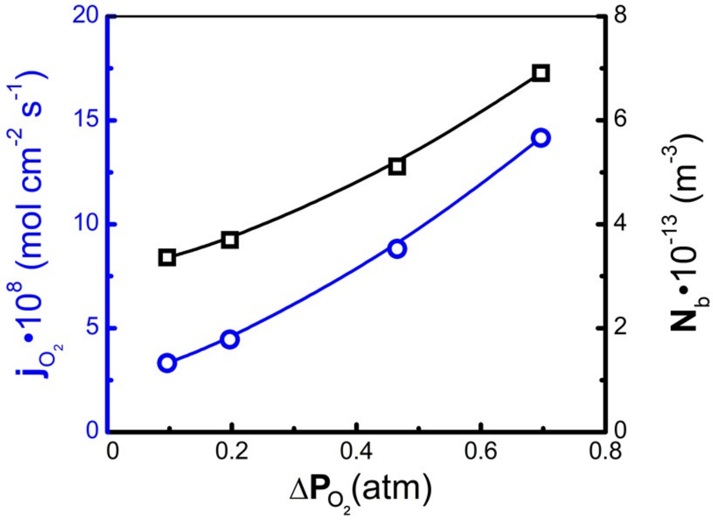

e

Figure S2. (a) – (d) Bubble size distribution in the core of CuO – 25 wt% $Cu_5V_2O_{10}$ DBM and cumulative oxygen flux through this membrane: (a) $\ln(P'_{O_2}/P''_{O_2})$ = 2.04, (b) $\ln(P'_{O_2}/P''_{O_2})$ = 2.35, (c) $\ln(P'_{O_2}/P''_{O_2})$ = 2.72, and (d) $\ln(P'_{O_2}/P''_{O_2})$ = 2.91 [2]. (e) Bubble density in the core of the DBM vs oxygen partial pressure difference across the membrane [2].

Viscosity

Table S1. Measured viscosities in Cu_2O melts in equilibrium with Cu [3].

First measurement C8		Second measurement C14	
Temperature/ K	Viscosity/ Pa s	Temperature/ K	Viscosity/ Pa s
1588	0.0109	1588	0.0098
1573	0.0117	1573	0.0101
1548	0.0123	1548	0.0110
1523	0.0141	1523	0.0137
1513	0.0147		

Oxygen adsorption

The parameter $\Gamma = \Gamma_1 - \Gamma_2$, where Γ_1 and Γ_2 are the adsorption of oxygen at opposite poles of the bubble, was estimated for the DBM operating temperature (830 °C) at different oxygen partial pressure P'_{O_2} and P''_{O_2} by extrapolation of the data presented in Fig. S3 using the Box Lucas model (https://www.originlab.com/doc/Origin-Help/BoxLucas1-FitFunc) in OriginPro 8: $\Gamma_i = a\left(1 - e^{-\frac{b10^3}{T}}\right)$, where i = 1, 2 and a and b are the fitting factors (Table S2).

Table S2.

P'_{O_2}	a×10^16	b	Γ_1×10^4 mol m^-2	P''_{O_2}	a×10^17	b	Γ_2×10^4 mol m^-2	Γ×10^5 mol m^-2
0.10	-1.13	-31.3811	2.25	0.013	-6.22	-31.9194	2.02	2.27
0.21	-1.39	-31.1869	2.34	0.020	-7.06	-31.8052	2.07	2.71
0.50	-1.79	-30.9609	2.45	0.033	-8.16	-31.6728	2.12	3.25
0.75	-2.01	-30.8557	2.50	0.041	-8.69	-31.6155	2.14	3.54

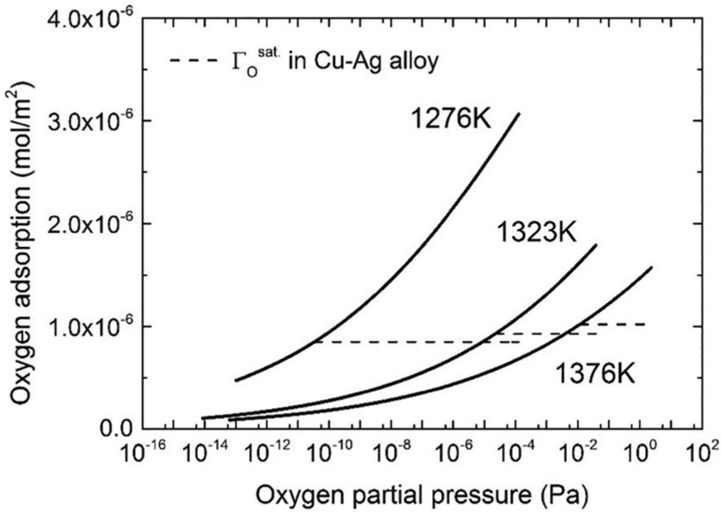

Figure S3. Oxygen adsorption on the surface of Ag\\40Cu (in at.%) alloy at 1276, 1323 and 1376 K. (Dashed line: theoretically calculated oxygen adsorption at saturation on the Cu sites) [4].

References

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3. M. Chen, B. Zhao and E. Jak, Viscosity measurements of high "Cu_2O" containing slags in the "Cu_2O"-SiO_2-Al_2O_3 system in equilibrium with metallic Cu, Proceedings of the Ninth International Conference on Molten Slags, Fluxes and Salts (MOLTEN12), 2012, Beijing, May 27th – 30th, China: The Chinese Society for Metals, W082-12.
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