## Electronic Supplementary Information for:

# Carbon Dioxide Capture and Utilization: Using Dinuclear Catalysts to Prepare Polycarbonates 

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## 1. Results



Figure S1. ${ }^{1} \mathrm{H}$ NMR ( $400.0 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{1}, 298 \mathrm{~K}$ ) spectrum of $\mathrm{LZn}_{2}\left(\mathrm{O}_{2} \mathrm{CCF}_{3}\right)_{2}(\mathbf{1})$. The asterisk denotes the residual protio-solvent.



Figure S2. Top: ${ }^{1} \mathrm{H}$ NMR ( $400.0 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{l}, 298 \mathrm{~K}$ ) spectrum of crude poly(vinyl-cyclohexene oxide) reaction mixture. Bottom: ${ }^{1} \mathrm{H}$ NMR ( $400.0 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{1}, 298 \mathrm{~K}$ ) spectrum of vinyl cyclohexene oxide monomer. The conversion of V-CHO to PVCHC was calculated by the ratio of integration of c to the integration of $\mathrm{d}+\mathrm{d}$ '. The asterisk denotes the residual protio-solvent.


Figure S3. ${ }^{1} \mathrm{H}$ NMR ( $400.0 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{1}, 298 \mathrm{~K}$ ) spectrum of isolated poly(vinyl-cyclohexene oxide) (PvCHC, $M_{n}=6,700 \mathrm{gmol}^{-1}$ ). The asterisk denotes the residual protio-solvent.


Figure S4. Bimodal molecular weight distribution of the isolated PvCHC polymer (Table 1 Entry 4), obtained by SEC using narrow $M_{w}$ polystyrene calibration.


Figure S5. Top: bimodal molecular weight distribution of the isolated PCHC polymer (Table 1 Entry 2), obtained by SEC using narrow $M_{w}$ polystyrene calibration. Bottom: MALDI-ToF spectrum of the PCHC produced in Table 1 Entry 2, showing the polyol series $\left[\mathrm{HO}\left(\mathrm{C}_{7} \mathrm{H}_{10} \mathrm{O}_{3}\right)_{\mathrm{n}} \mathrm{C}_{6} \mathrm{H}_{11} \mathrm{O}_{2}\right] \mathrm{K}^{+}=$ [(142.15) $\left.{ }_{\mathrm{n}}+116.16+39.1\right]$


Figure S6. ${ }^{1} \mathrm{H}$ NMR ( $400.0 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{1}, 298 \mathrm{~K}$ ) spectra of separated fractions (Top: low $M_{n}$ fraction, Bottom: high $M_{n}$ fraction) of PCHC produced in Table 1 Entry 2. The asterisks denote the residual solvent.


Figure S7. Top: molecular weight distribution of the isolated high $M_{n}$ fraction of PCHC polymer (Table 1 Entry 2), obtained by SEC using narrow $M_{w}$ polystyrene calibration. Bottom: MALDI-ToF spectrum of the high $M_{n}$ fraction of the PCHC produced in Table 1 Entry 2, showing the polyol series $\left[\mathrm{HO}\left(\mathrm{C}_{7} \mathrm{H}_{10} \mathrm{O}_{3}\right)_{\mathrm{n}} \mathrm{C}_{6} \mathrm{H}_{11} \mathrm{O}_{2}\right] \mathrm{K}^{+}=\left[(142.15)_{\mathrm{n}}+116.16+39.1\right]$


Figure S8. Monomodal molecular weight distribution of the PCHC polymer using 10 equiv. CHD in the polymerization (Table 3 Entry 2), obtained by SEC using narrow $M_{w}$ polystyrene calibration.




Figure S9. ${ }^{1} \mathrm{H} \mathrm{NMR}\left(400.0 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{1}, 298 \mathrm{~K}\right)$ spectrum of isolated poly(cyclohexene oxide) produced in the polymerization with TEA additive $\left(M_{n}=1,500 \mathrm{gmol}^{-1}\right.$, Table 3, Entry 5). The asterisk denotes the residual protio-solvent.


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\mathrm{R}=\text { polymeryl; } \mathrm{R}^{\prime}=\text { alkyl }
$$


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Figure S10. ${ }^{31} \mathrm{P}\left\{{ }^{1} \mathrm{H}\right\}$ NMR spectra $\left(162.1 \mathrm{MHz}, \mathrm{CDCl}_{3}-d_{1}, 298 \mathrm{~K}\right)$ of the products of the reactions between the amine reagent $\left(\mathrm{H}_{2} \mathrm{NBn}, \mathbf{B}\right)$ or polymer end groups ( $\mathbf{A}$ and $\mathbf{B - F}$ ) and 2-chloro-4,4,5,5tetramethyl dioxaphospholane. The asterisks, triangle, daggers and double daggers denote resonances corresponding to the product of the dioxaphospholane with secondary alcohol ( $\delta=145.5 \mathrm{ppm}$ ), primary amine $(\delta=142.5 \mathrm{ppm})$, Bisphenol A $(\delta=138.0 \mathrm{ppm})$ and water $(\delta=132.0 \mathrm{ppm})$, respectively.


Figure S11. MALDI-ToF spectrum of the isolated $\operatorname{PCHC}\left(M_{n}=1,500 \mathrm{~g} \mathrm{~mol}^{-1}, \mathrm{PDI}=1.23\right)$ produced in the polymerization with TEA additive (Table 3, Entry 5), showing the polyol series $\left[\mathrm{HO}\left(\mathrm{C}_{7} \mathrm{H}_{10} \mathrm{O}_{3}\right)_{\mathrm{n}} \mathrm{C}_{6} \mathrm{H}_{11} \mathrm{O}_{2}\right] \mathrm{K}^{+}=\left[(142.15)_{\mathrm{n}}+116.16+39.1\right.$.


Figure S12. Combined SEC traces of PCHC produced using 20 equiv. $\mathrm{HNBn}_{2}$ in Table 3 Entry 5, with RI detection (red) and UV detection (blue), using THF as the eluent.

## 2. References

1. M. R. Kember, J. Copley, A. Buchard and C. K. Williams, Polym. Chem., 2012, 3, 1196-1201.
