Figures in presentations, papers, and TOC Art

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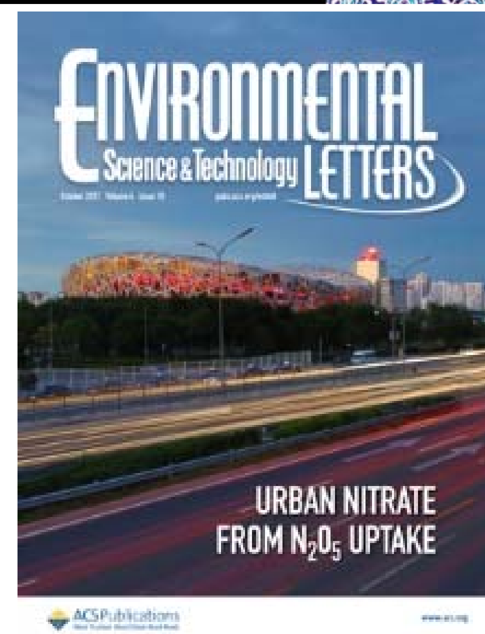
Engineering Energy &
Environmental Institute

Topics for this presentation

- Getting started
  - Slide colors and format
- Figures
  - Striving for clarity
- Challenges:
  - Powerpoint vs journal papers
- TOC Art
- A few presentation tips…



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Some slide formats use a lot of room

The first thing you write is already 1/3 down the page. This means your most important material is on the bottom of the slide, which may be difficult to see….

Consider first the slide background…

Can you really read this very well?

- Careful NOT to have too “busy” a background in the slide.

Thinking about ways to present your data

The colors you can use depends
on the background!

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Thinking about ways to present your data

The colors you can use depends
on the background!

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Thinking about ways to present your data

The colors you can use depends
on the background!

Thinking about ways to present your data

The colors you can use depends on the background!

Black backgrounds are GREAT… but only in dark rooms

A white background provides light into the room and will show up better in rooms that are either dark or that have more light.

Red colors look great on Black (or white) backgrounds, but not on blue backgrounds

Oil and Fossil Fuels

- Global industrial growth is increasing the de energy
  - Peak in US oil production 30 years ago produce
  - Global production of oil will peak in the next 1
  - CO_2 emissions continue to increase causing clim
- **Energy alternatives that st (nuclear, coal hydrates?) pose continued environmental c**

Choose fonts that are clear (these letters are too close).

Use a bigger font rather than a bold font (these are too bold)

Figures

- Nothing demonstrates the quality of the paper more than the quality of the figures!
  - Bad figures = bad science?
- Create beautiful figures.
  - They provide clarity to your results, and demonstrate a professional approach and tells the reader you pay attention to details.
  - Are your figures appealing? Or a bit scary… (!)

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Graphs and Figures:

If you use the Excel default font size, it is probably too small!

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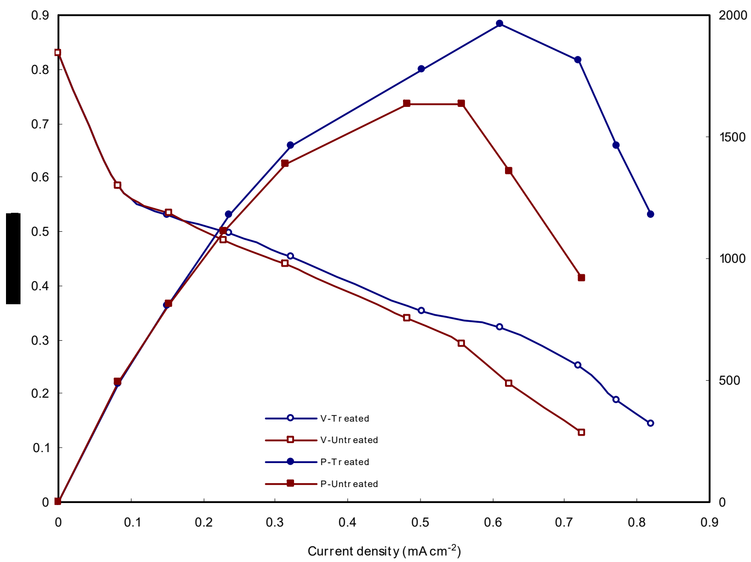
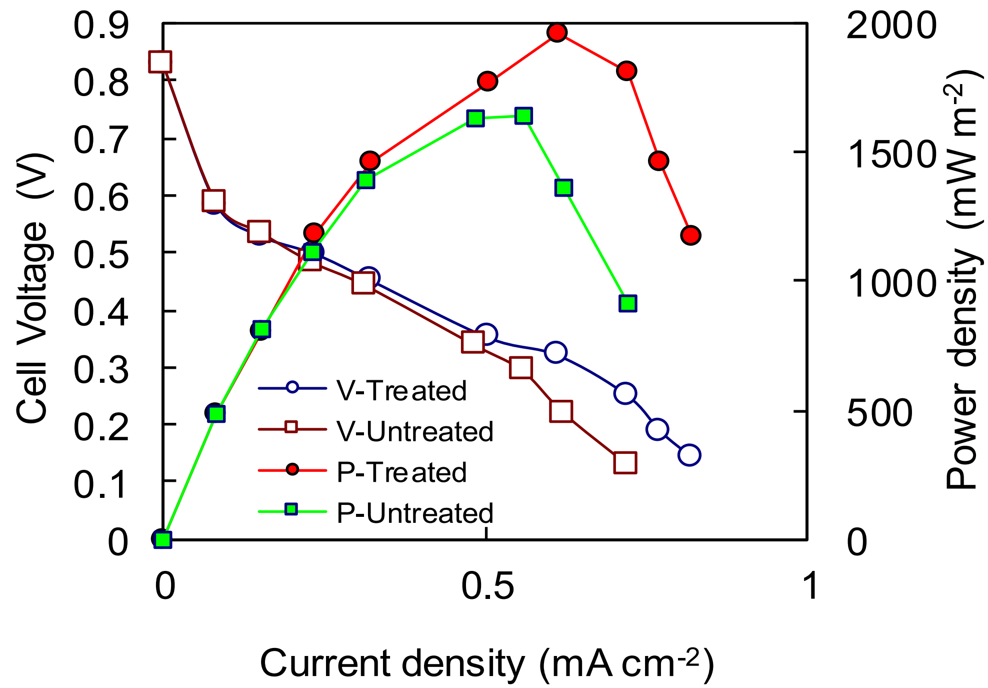
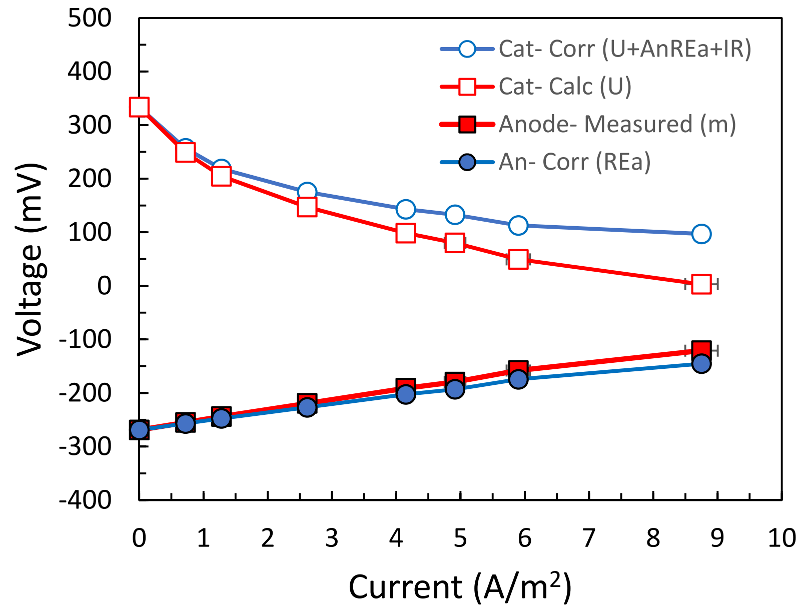
Increase font and marker sizes





Consistent colors help



- Fonts: Ariel or Calibri, or ?? (Avoid Times New Roman and similar fonts)
- Color code as much as reasonable/possible
- Keep legends informative (difficult in this case without equations)
- If legend the same in multiple plots, only show once (not the case here)

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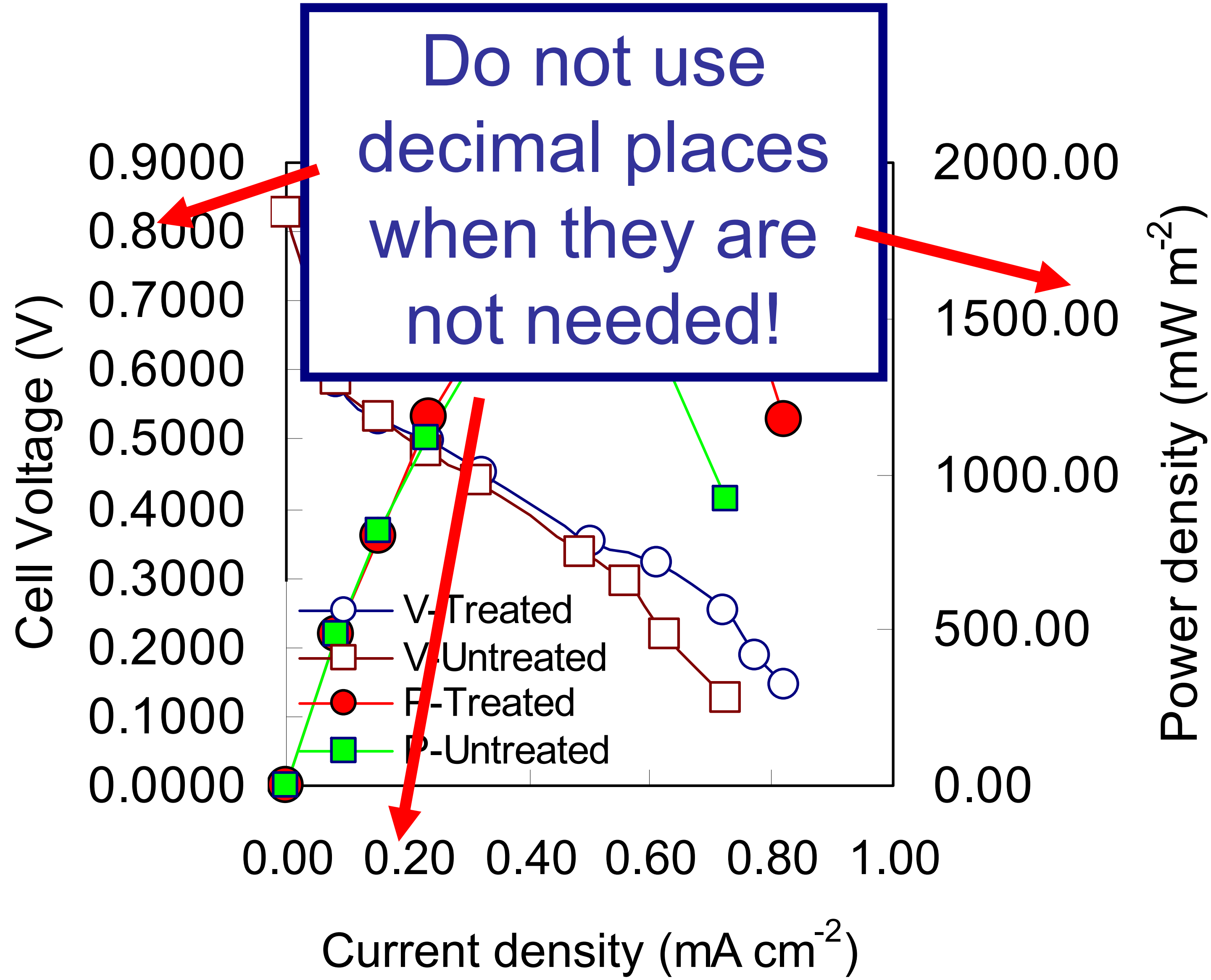
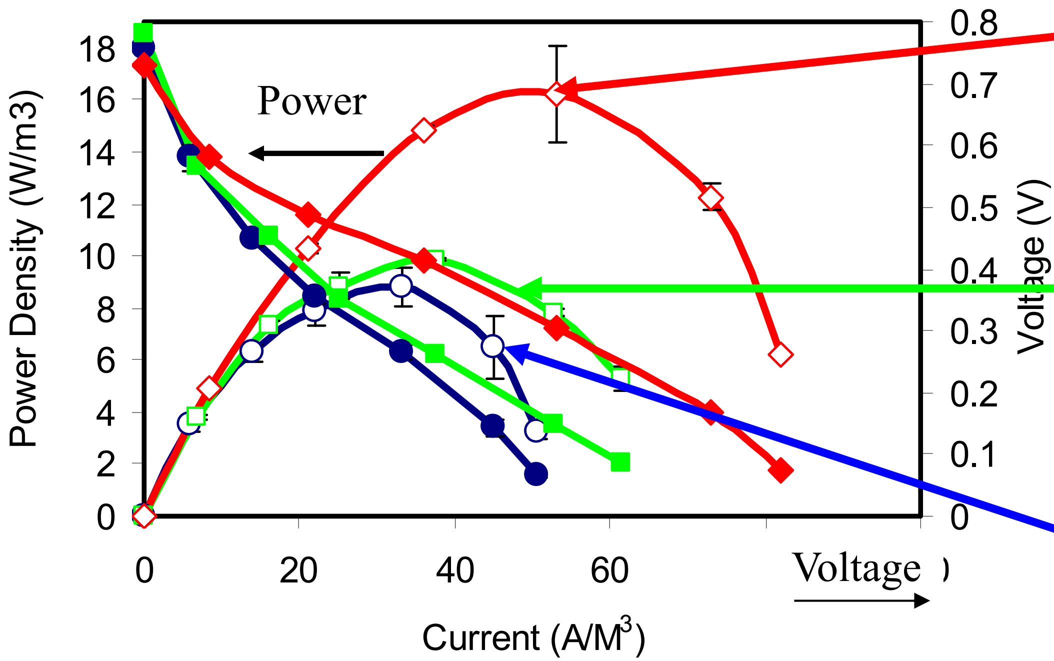
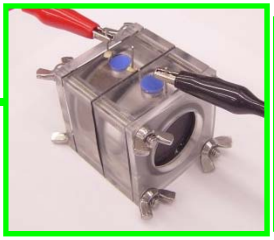


Adapted from: Cheng & Logan (2006) *Electrochem. Commun.*

Match colors with graphs to help with complex figures



Hydrophobic tube cathode
(CoTMPP, 113 m^2/m^3)
16 W/m^3



Carbon flat cathode
(Pt, 25 m^2/m^3)
10 W/m^3

Hydrophilic Tube Cathode
(CoTMPP, 84 m^2/m^3)
9 W/m^3

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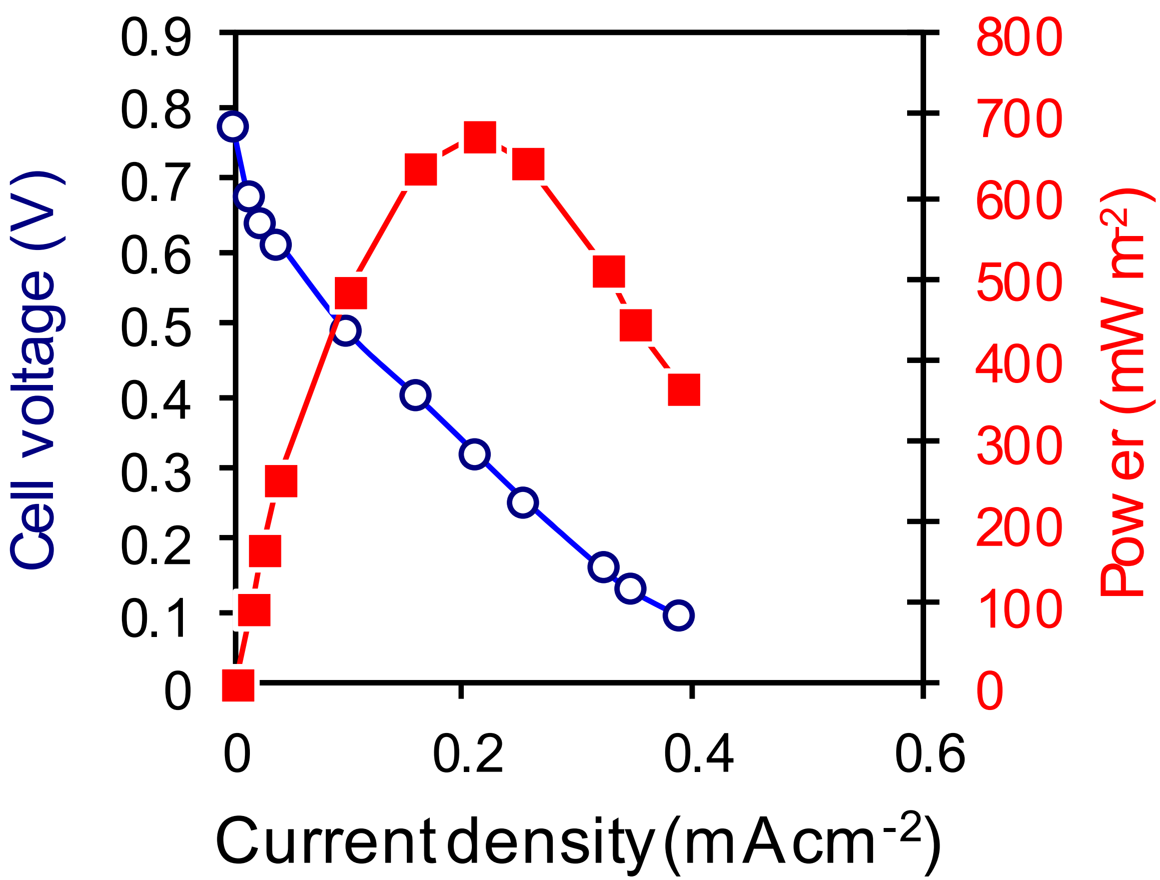
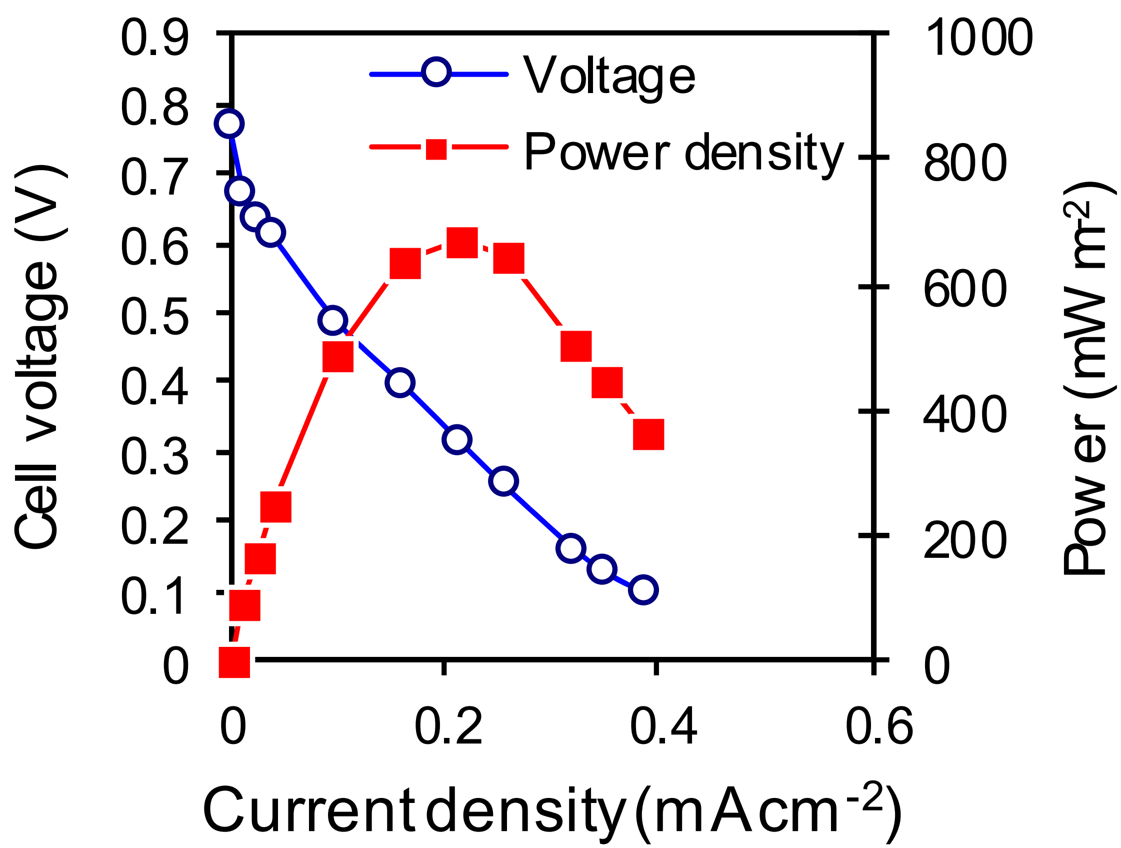
Zuo et al. (2007) *Environ. Sci. Technol.*

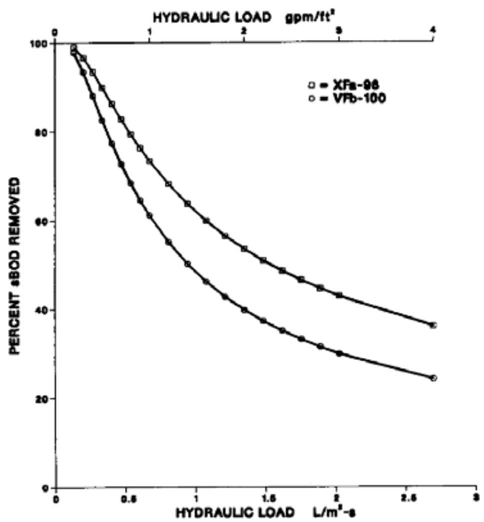
Here, the different *y* axes are color coded

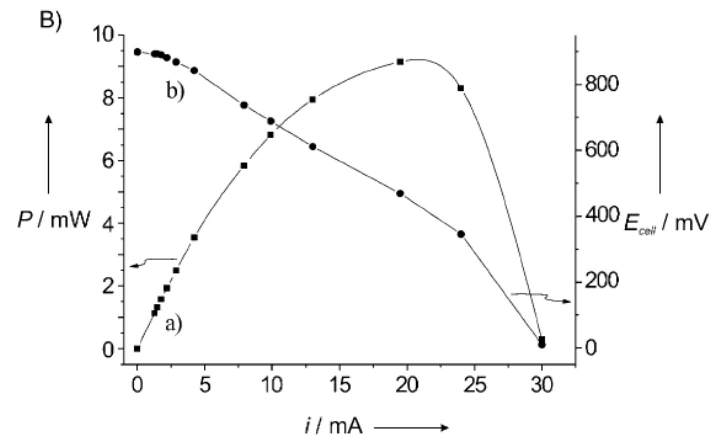


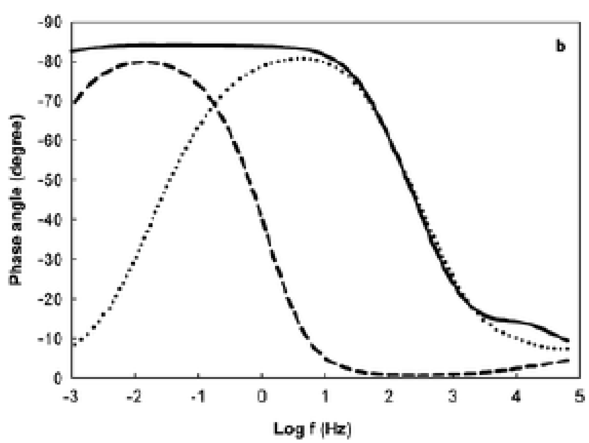
Legend is used here, with large, clear letters

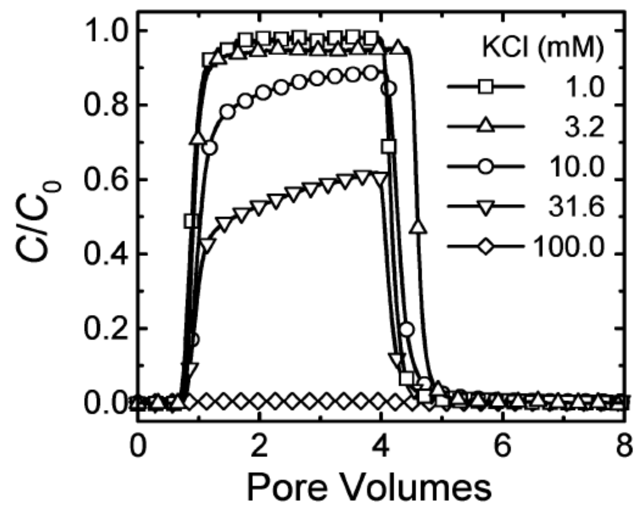


Examples of published figures









Logan et al. (1987) *J Wat Pollut. Control Fed.*

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He & Mansfield, *Energy & Env. Sci.*, 2008.

Schroder et al. (2003), *Angew. Chem. Int. Ed.* 2003

Redman et al. (2004) *Environ. Sci. Technol.*

Watch font sizes…
here, the legend is impossible to read…

T.-S. Song, H.-L. Jiang / Bioresource

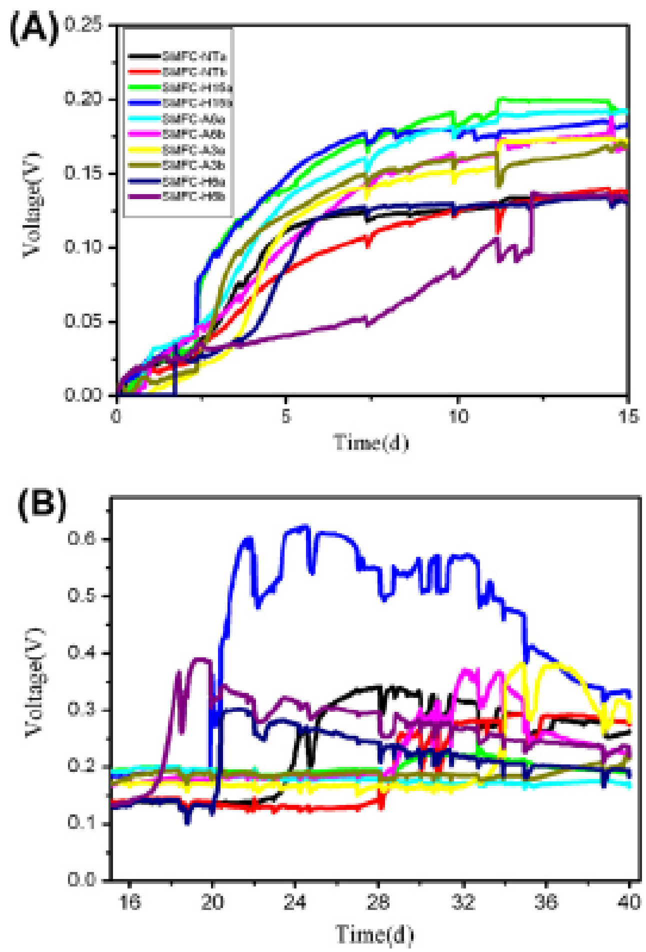

Fig. 1. Voltage generation of SMFCs produced with sediments subjected to different pretreatment methods. (A) 0–15 days and (B) 15 days onwards.

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Comment on figures and layout in proofs

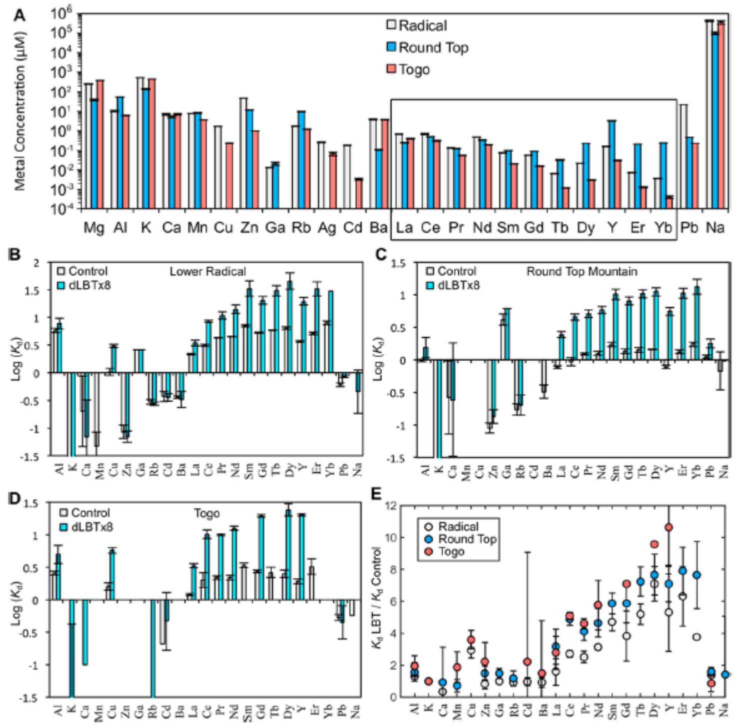

Figure 4. Selective adsorption of REEs from Lower Radical, Togo, and Round Top Mountain leachates. (A) Metal concentration profile of pH-adjusted (6.0) leachates prior to adsorption. The 11 REEs present are boxed. Note that the high Na levels were a result of NaOH added during pH adjustment. Metal distribution coefficient (K_d) for LBT-displayed (*lpp-ompA*-dLBTx8, induced with arabinose) and control (*lpp-ompA*-dLBTx8, no arabinose induction) *E. coli* W3110 cells (DMP489) for Lower Radical (B), Round Top Mountain (C), and Togo leachates (D). For Togo leachates, the concentrations of Tb, Er and Yb remaining in solution after biosorption with the LBT-displayed strain were below the detection limit of ICP-MS, and thus, K_d values could not be accurately determined. See SI Figure S1 for plots of the fraction of each metal bound by both strains. (E) Ratio of metal distribution coefficients for the LBT-displayed strain relative to the control. Ratios greater than 1 reflected more efficient extraction by the LBT strain. For all plots, REEs are listed in order of decreasing atomic radii,[54] and error bars represent the standard deviation of biological triplicates. Note that although we quantified Na concentrations, these were not factored into the total metal concentrations as the majority of Na was added exogenously during pH-adjustment.

Table 2. Conditional Selectivity Coefficients ($K_s^{Nd,M}$) for Nd[a]

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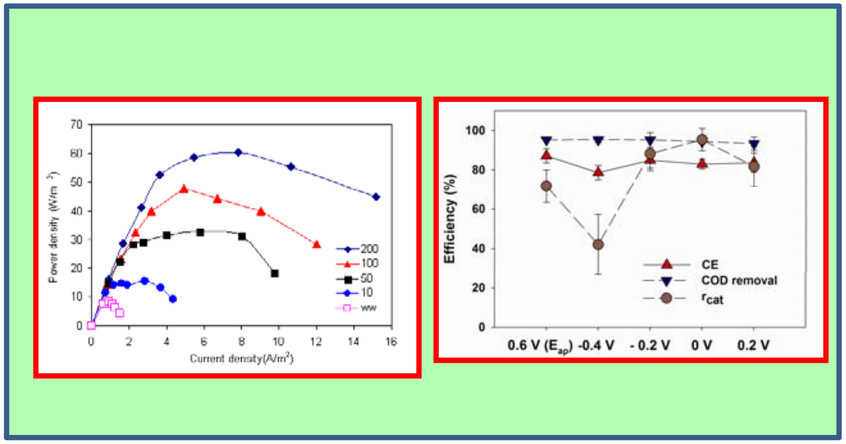
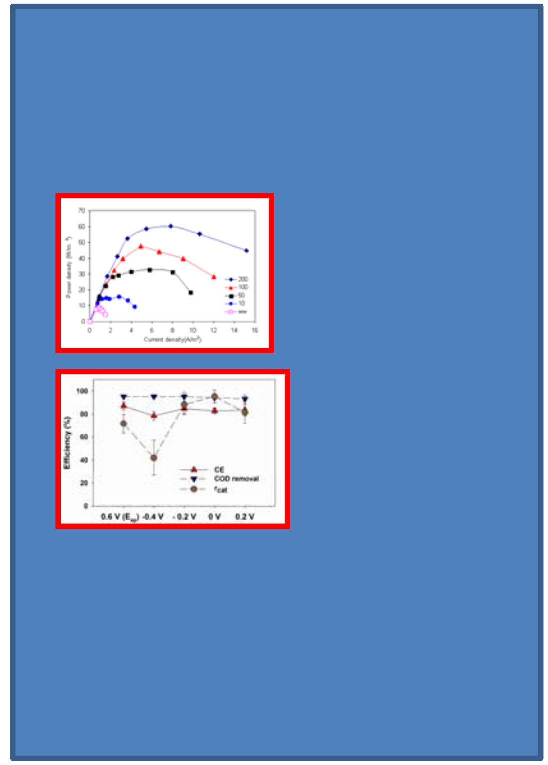
Park et al. (2017), Environ. Sci. Technol.

Powerpoint formats vs Papers





Think about figure layout in the journal:

Poor layout leads to the use of two columns for a figure that should only take 1 column

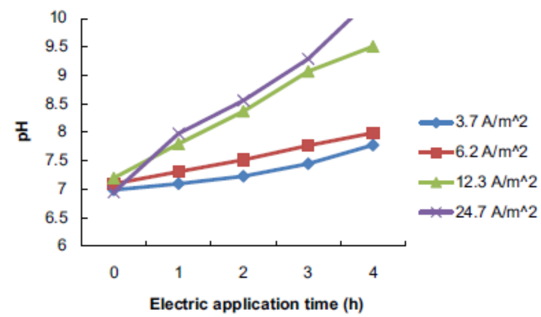


Fig. 4 – Effect of current intensity and duration on pH.

12.3 A/m^2. Fig. 5 demonstrated that the biomass's SOUR dropped by 42% after 4 h of electric inactivation at current density of 24.7 A/m^2.

The temperature changes observed during application of electric current at room temperature were displayed in Fig. 6. The maximum change at all current densities during 4 h was less than 2 °C. Therefore, the temperature changes monitored should not have caused any bacterial inactivation effect.

Bacteria experience different micro-environment in an electrochemical reactor, especially when the reactor is not stirred or there is little mixing. As shown in Fig. 7, bacterial cells on the cathode surface were directly subjected to significantly elevated pH and action of electric field, consequently exhibiting highest death rate, whereas bacteria outside the space between electrodes had the highest viability because they were beyond influence of the electric field and are least affected by the toxicity of electrochemical byproducts. Therefore, for a wastewater treatment process in which an electro-technology is incorporated, a strong mixing is desirable to enhance dispersion and diffusion of microorganisms and prevent localized cell inactivation.

Direct currents may also be used to stimulate bacterial activity and metabolism in a process called electrostimulation. Several studies have been conducted on the stimulatory effects of low level direct currents on microbial growth. Nakanishi et al. (1998) reported that electrostimulation of cells induces changes in DNA and protein synthesis, membrane permeability and cell growth and revealed that at low level current, bacterial activity and metabolism which were measured in terms of alcohol production were enhanced; the mechanism of these changes is still not well understood. In the research reported here the electro-stimulation effect was not observed.

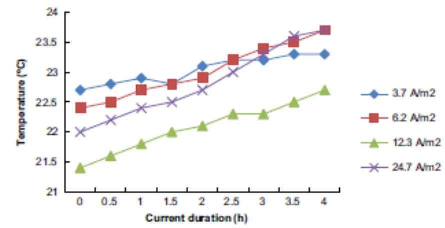


Fig. 6 – Effect of current intensity and duration on the biomass temperature.

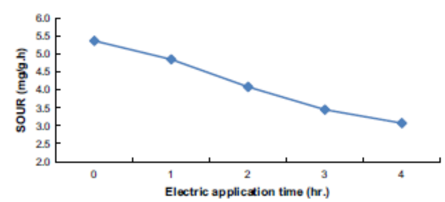


Fig. 5 – SOUR of biomass vs. current duration (current density 24.7 A/m^2).

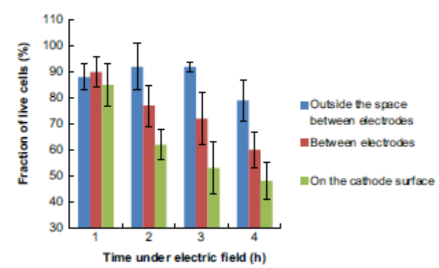


Fig. 7 – Bacterial viability in the different zones relative to electrodes when no mixing was applied in the reactor (current density = 12.3 A/m^2).

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In a combined MFC-PEC system, ABRX3 removal in the anode chamber and the appropriate voltage for photoelectrode should be checked simultaneously. Fig. 3(A) showed ABRX3 decolorization in the MFC. During the first 6 h of operation, the ABRX3 concentration decreased to 150 mg/L. Then, ABRX3 concentration decreased to 70 mg/L during the final 30 h. The ABRX3 concentration of the effluent was lower at 350 Ω and 500 Ω (48.0 ± 6.9 mg/L and 42.0 ± 8.9 mg/L, respectively) than that for the other resistors. However, the ABRX3 concentration under open circuit status was 93 ± 5.7 mg/L which was higher than that in closed circuit status. Based on the first-order kinetic fitting analysis of ABRX3 decolorization, the highest kinetic constant (0.061 h^{-1}) was observed in the MFC with 500 Ω, which had the highest removal rate.

In the MFC anode, the current contributed to the breaking of the azo bond, which was attributed to the attendance of anode. The anode provided sufficient electron acceptor for microbial metabolism, accelerating the metabolic rate of microorganisms and the use of substrate, thus facilitating the generation of electrons and the reduction of azo dyes (Morris et al., 2009; Sun et al., 2011). Therefore, the COD and ABRX3 removal in open circuit status was lower than that in closed circuit status. Compared with traditional anaerobic degradation, the MFC significantly improved the

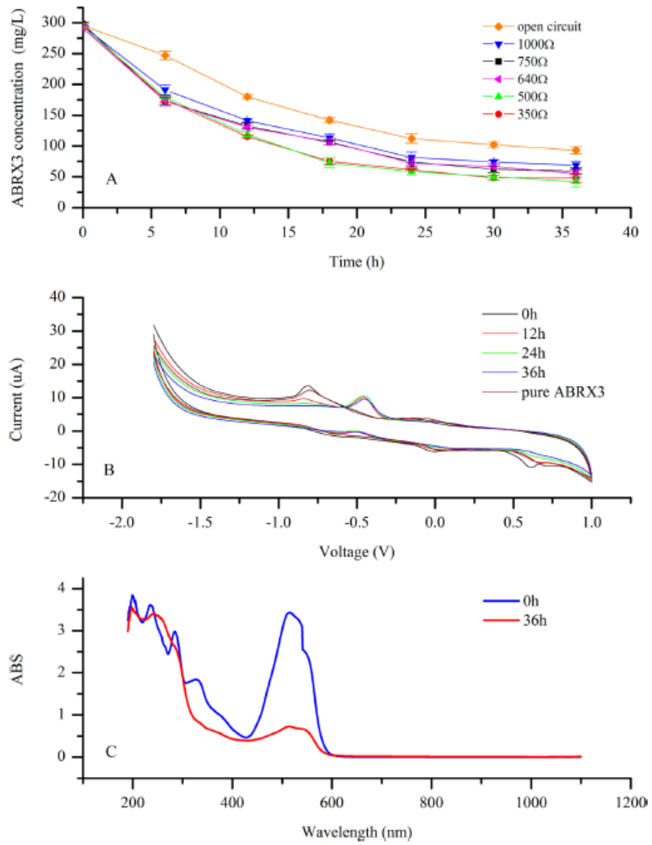

Fig. 3. ABRX3 degradation with different resistors in MFC. (A) ABRX3 decolorization during 36 h. (B) Cyclic voltammogram of anolyte. (C) UV–VIS absorbance of influent and effluent of MFC.

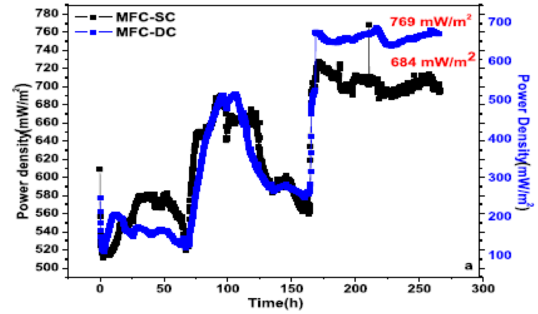

Fig. 2. Power density of MFC-DC and MFC-SC reactors in closed circuit.

Subbaraman et al., 2010; Biffinger et al., 2008; Venkata Mohan et al., 2008b). Where, the E_{we} (vs. Ag/AgCl (3.5 M KCl)) of MFC-DC (−462 mV (OCV); −0.0391 mV (1 KΩ,)) showed improved performance as compared to the MFC-SC (−364 mV (OCV); −0.0331 mV (1 KΩ)) in unison with the E_{ce} (Fig. 1b). The enhancement of E_{we} can be attributed to the improved substrate degradation rate exhibited due to the higher reducing equivalent gradient created by the accelerated ORR in the cathode chamber. The experimental result correlated well with the improved substrate utilization and the biocatalytic activity monitored and discussed in the following subsections. Comparatively lower E_{we} than E_{ce} favors higher electron discharge from the biocatalyst which results in improved bioelectrogenic activity with enhanced rate kinetics (Gao et al., 2014; Gautam et al., 2016; Aelterman et al., 2008).

3.2. Power density-closed circuit mode

The improved rate kinetics will also decrease the electrochemical losses (activation, ohmic and concentration) occurring during operation of MFC, which have direct influence on the power output (Zhang et al., 2014; Venkata Mohan et al., 2009). With the maximum OCV generation, post the stabilization phase the fuel cells were operated in closed circuit mode to determine the power density, where, MFC-DC achieved higher PD (769 mW/m^2) in comparison to 684 mW/m^2 with MFC-SC (Fig. 2). The higher power output can be attributed to the improved and continuous electron transfer due to the high and stabilized OCV with lower electrochemical losses. The improved electron drive towards cathode is a function of the proton motive force (PMF) generated due to the proton gradient across the PEM. However, the proton gradient is in turn dependent on the availability of the O_2 as TEA, were the DO in MFC-DC enabled higher PMF in contrast to the air cathode operation.

3.3. Polarization profile

To study the sustainable power production and bio-electrochemical losses influenced by the phasic variation of O_2, the polarization curves were plotted at the stable phase of operation with the function of varying R_E (30 to 0.05 KΩ) (Molognoni et al., 2014; Venkata Mohan et al., 2014b; Mohanakrishna et al., 2017). The polarization profile of both the MFCs showed a cell design point (CDP) of 1 KΩ accounting for a maximum PD of

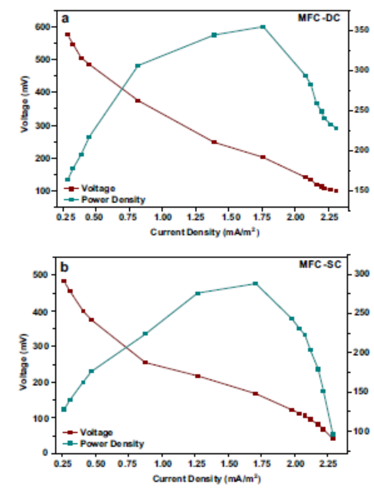

Fig. 3. Polarization curves showing CDP of MFC-DC and MFC-SC reactor.

0.355 mW/m^2 (MFC-DC) and 0.288 mW/m^2 (MFC-SC) (Fig. 3). The high CDP resembles the application feasibility of the MFC setup with an operating load of 1 KΩ which are in the order of a small LEDs, rotary disc, etc. The higher PD can be ascribed to the collective influence of the specifically designed fuel cell configuration, electroactive bacteria (pre-treatment) and the optimized operational parameters. A proportional increment in power output was observed with decrease in the external resistance (R_E) due to presence of electron acceptors in the catholyte driving the electrons without hindrance. With a high CDP, the fuel cell showed low

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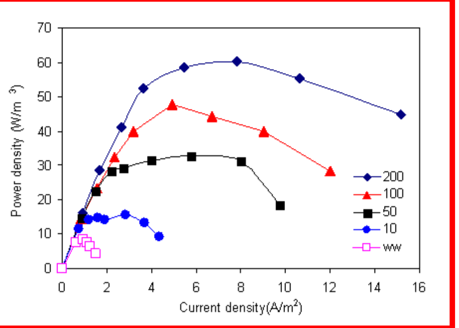
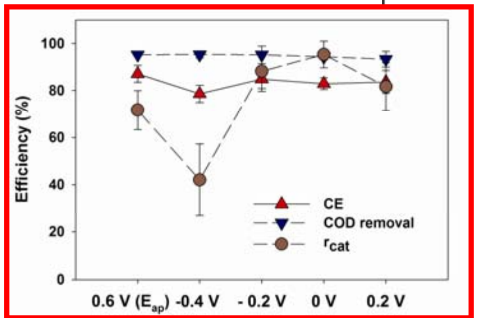




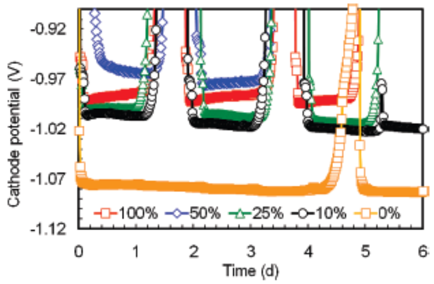


FIGURE 3. Cathode potentials (versus Ag/AgCl) versus time for consecutive batch cycles using SS brush cathodes with different bristle loadings at E_{ap} = 0.6 V.

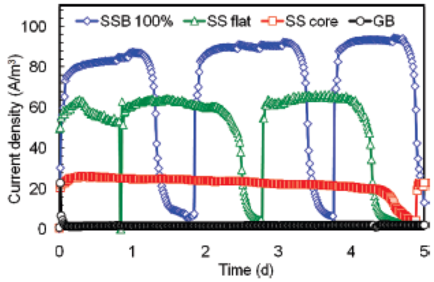


FIGURE 4. Current densities versus time for a 100% loaded SS brush cathode (SSB 100%), a flat SS cathode (SS flat), a SS brush core (SS core), and a graphite brush cathode (GB) at E_{ap} = 0.6 V.

graphite brush. Thus, large surface area alone could not account for the performance of the SS brushes.

The importance of the SS as a catalyst was further verified by using a flat SS cathode in Reactor FC. Although the specific surface area of the flat SS cathode was more than a hundred fold smaller than the graphite brush cathode, current generation was greater (64 ± 2 A/m³). The current density produced by the flat SS cathode (2.6 cm electrode spacing) was also 2.7 times greater than the SS brush core (24 ± 0 A/m³; 3.5 cm electrode spacing). Although the flat SS cathode had a slightly larger surface area (A = 7 cm²) than the SS brush core (A = 2.4 cm²), the higher current density of the flat SS cathode suggests that the orientation and distance of the cathode was more important for increased current density than surface area.

Comparison to a Platinized Cathode. Because the brush bristle loadings did not have an appreciable impact on current production, it was believed that the main factor limiting power generation was electrode distance. Therefore, a fully loaded SS brush was trimmed in half and placed as close as possible above a similarly trimmed graphite brush anode (Reactor VB, A_S = 810 m²/m³) in order to create a configuration capable of generating current densities similar to Pt/C cathodes (*6*). During the first few cycles, the current density was greater in the MEC using the Pt/C cathode (Reactor FC) than in the MEC with the vertically aligned SS brush cathode (Figure 5). Within four cycles, however, Reactor VB was producing the highest current density of 194 ± 1 A/m³, compared to 182 ± 2 A/m³ for Reactor FC. For the final three batch cycles, both reactors generated a similar average current density, with

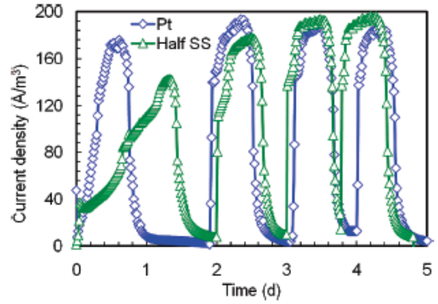


FIGURE 5. Current density versus time for both the platinized carbon cloth cathode (Pt) and the SS brush cathode cut in half (Half SS) at E_{ap} = 0.6 V.

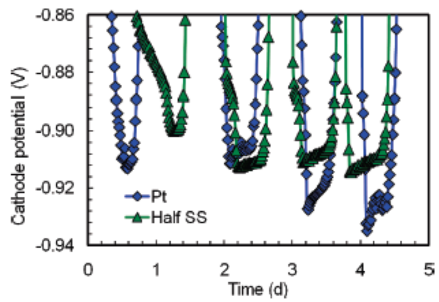


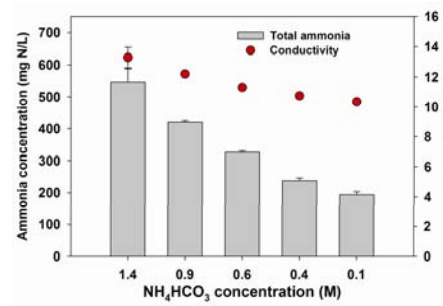
FIGURE 6. Cathode potentials (versus Ag/AgCl) versus time for both the Pt/C cathode and the SS brush cathode cut in half (Half SS) at E_{ap} = 0.6 V.

Reactor FC reaching 188 ± 10 A/m³ and Reactor VB obtaining 186 ± 2 A/m³.

The higher current density of Reactor VB with the SS brush was a result of a lower cathodic overpotential than that of Reactor FC with the Pt/C cathode (Figure 6). During the first batch cycle, the Pt/C cathode had a higher overpotential than that of the SS brush, likely due to the higher current density. By the second cycle, both the SS brush and Pt/C cathode exhibited roughly the same overpotential, but several later cycles the Pt/C cathode showed an increase in overpotential (cycles 3 and 4). This trend may have been due to minor Pt catalyst inactivation in combination with an activation of the SS for the hydrogen evolution reaction (HER). After the first two cycles of reactor acclimation, the SS cathode in Reactor VB produced a cathode potential of −0.910 ± 0.002 V, whereas the Pt/C cathode exhibited a higher overpotential with a value of −0.924 ± 0.003 V. These potentials correspond to cathodic losses of about 0.29 V for the SS brush and 0.30 V for the Pt/C cathode relative to the equilibrium potential of hydrogen formation (−0.62 V vs Ag/AgCl).

Energy Recoveries and Production Rates. The recoveries and production rates for the SS brush in Reactor VB were averaged over the last three cycles in Figure 5. Relative to only the electrical energy input, the energy recovery reached η_E = 221 ± 8%. When the substrate energy was also included, the overall energy recovery was η_{E+S} = 78 ± 5%. The cathodic hydrogen recovery was r_{CAT} = 83 ± 8%, and the average hydrogen production rate was Q = 1.7 ± 0.1 m³-H_2/m³-d.

Linear Sweep Voltammetry. LSV scans performed only



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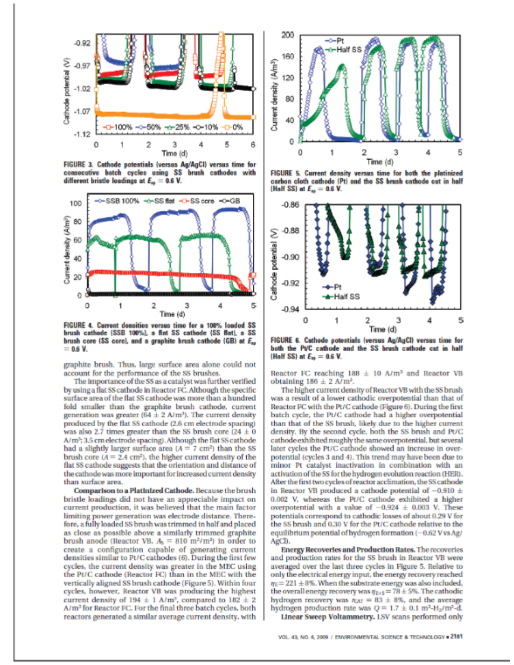
Figures

- Legends and notation
  - Keep notation simple: avoid long subscripts and superscripts
  - Legends should be clear (no boxes; all text inside the plot)
  - Don't repeat information (i.e. same units in all items)
- Fit the figure into one column width.
- Figures should have:
  - Large fonts
  - Large symbols (markers)
  - No bold letters (they don't reduce in size well)
  - No grid lines
  - Good use of marker types, colors, and shapes:



Figures

- Put all legends within the plot box, with no line around the legend box.
  - Either use legends or don't; don't mix it up within one paper.
  - Keep legends simple.
  - You only need one per figure if all plots the same.
- Avoid extra "non-information"
  - Use inside ticks (major and minor).
  - Choose colors so that the symbols, lines or bars all show well in black and white and color.
  - Do not use smoothed lines (just connect points).
  - Connect axes to form a boxed in plot
  - Use error bars when possible.

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Quiz 1

- What is wrong with these figures?

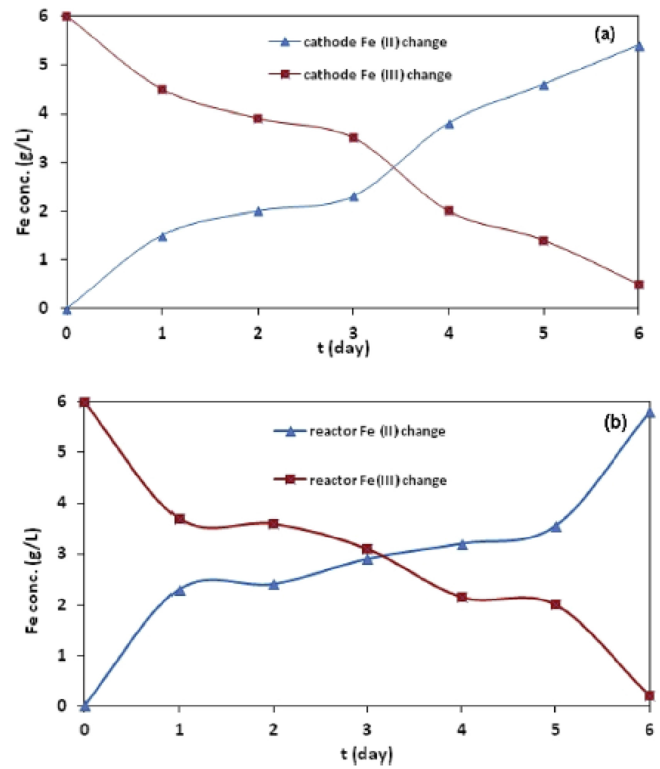

Fig. 3 – (a) Fe^{3+} and Fe^{2+} concentration change (g/L) in the cathode chamber with respect to time, (b) Fe^{3+} and Fe^{2+} concentration change at the reactor with respect to time.

Open circuit potential measurements

Open circuit potential is a value that indicates an increase in the activity of bacteria in direct proportion. Therefore, the open circuit potential value was allowed to arrive to a certain value within a certain time before starting the tests. This process and corresponding measurements are shown in the figures below.

During electrochemical measurements of the fuel cell, different pH values were researched. In Fig. 4, open circuit potential values were measured with respect to time during the experiment with the anode pH changes.

Once the system was started to operate, it was take a certain period of time for the biofilm formation on the electrodes, and for the system to reach equilibrium. The potential value measured during this period was low. The sharp drops in the curves are due to substrate depletion. It has been noted that the potential uptrend continues after substrate loading.

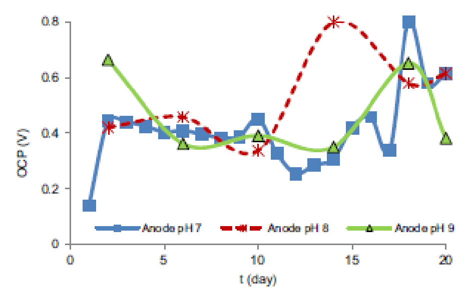

Fig. 4 – Open circuit potential curve of the cell relative to time.

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Quiz 2

INTERNATIONAL JOURNAL OF HYDROGEN ENERGY 42 (2017) 28681–28689

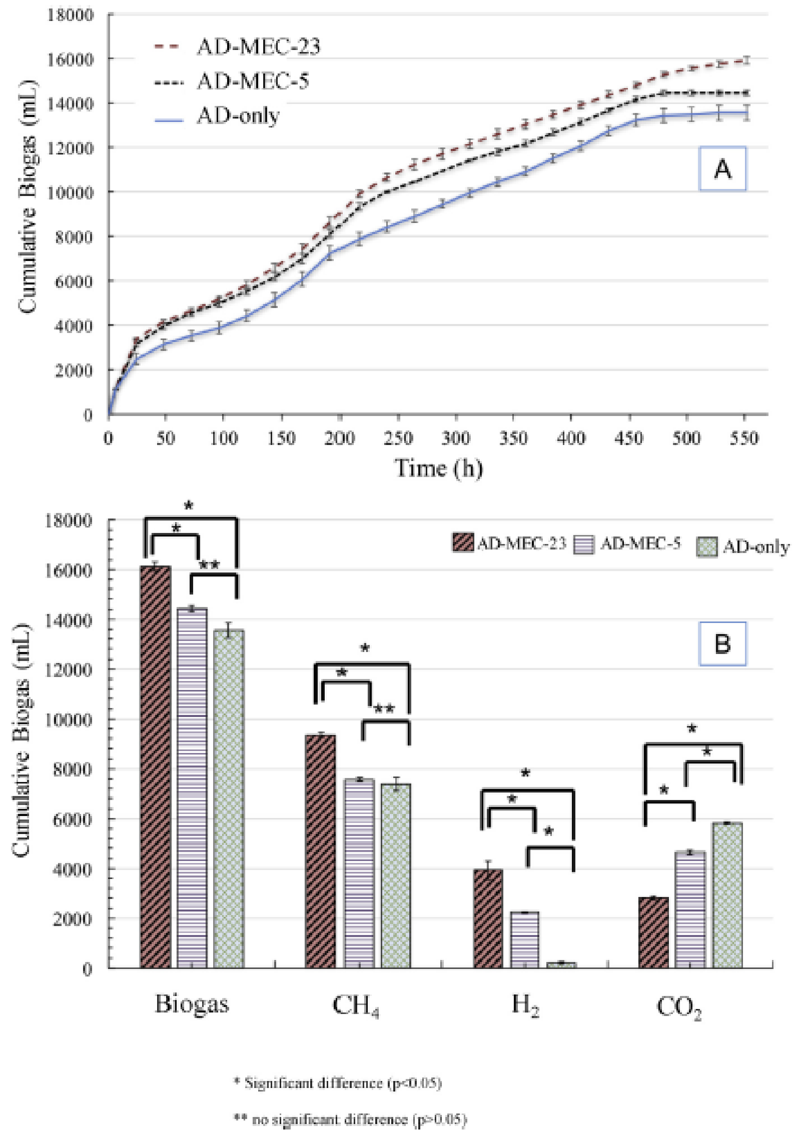

Fig. 3 – Cumulative biogas over the 23-day experiment (A), with cumulative biogas, CH_4, H_2, and CO_2 shown in (B). Significant differences were analyzed using Tukey-Kramer analysis with an *alpha* value of 0.05.

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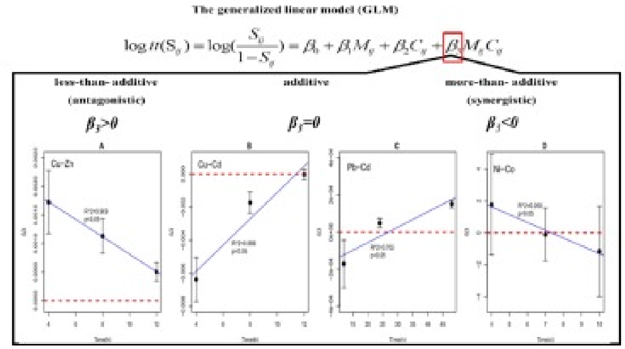
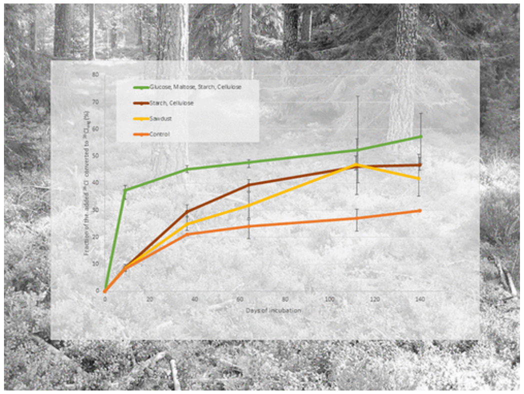
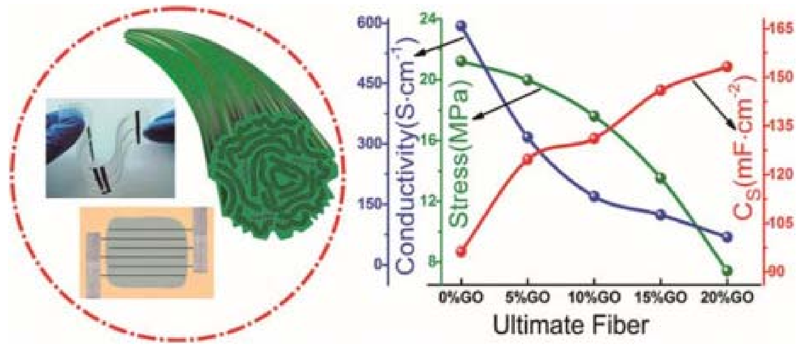
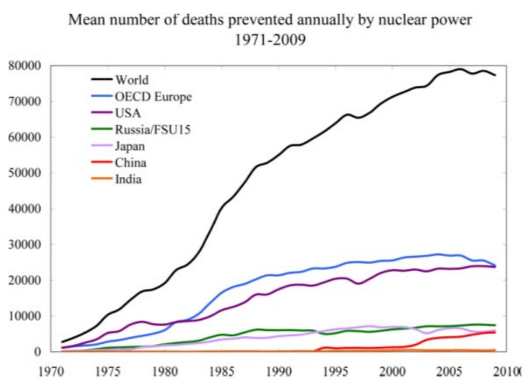
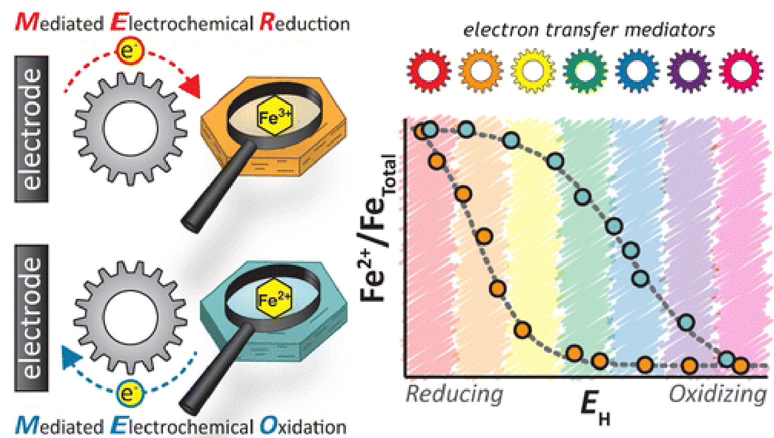
Table of Content (TOC) Art, or "Graphical Abstracts"



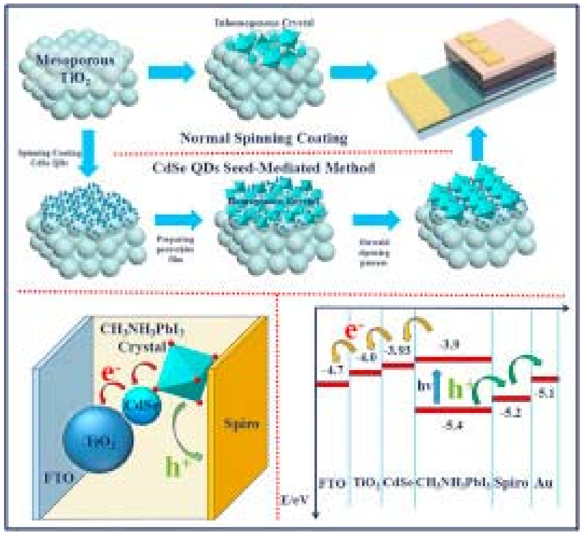


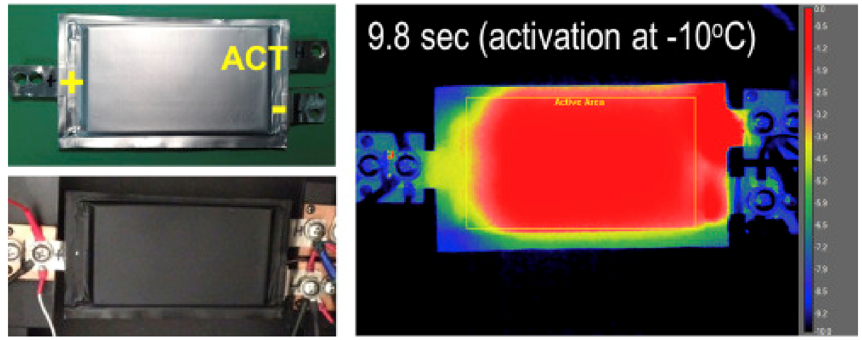


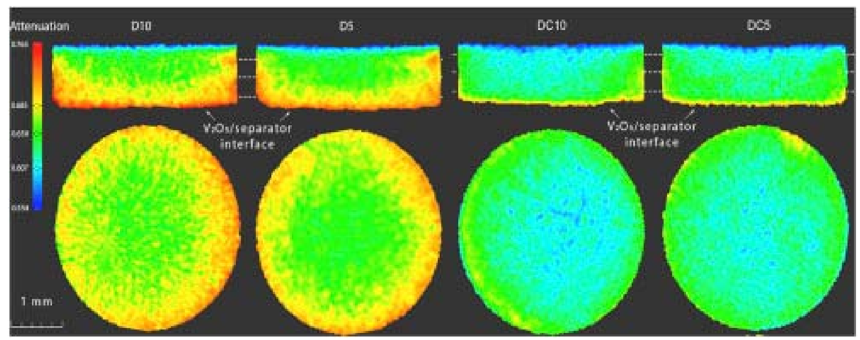


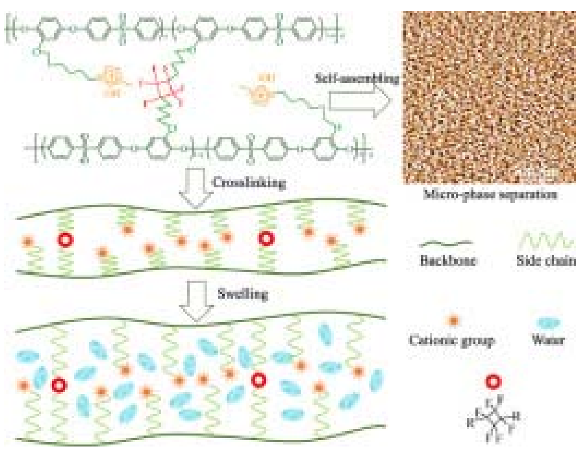


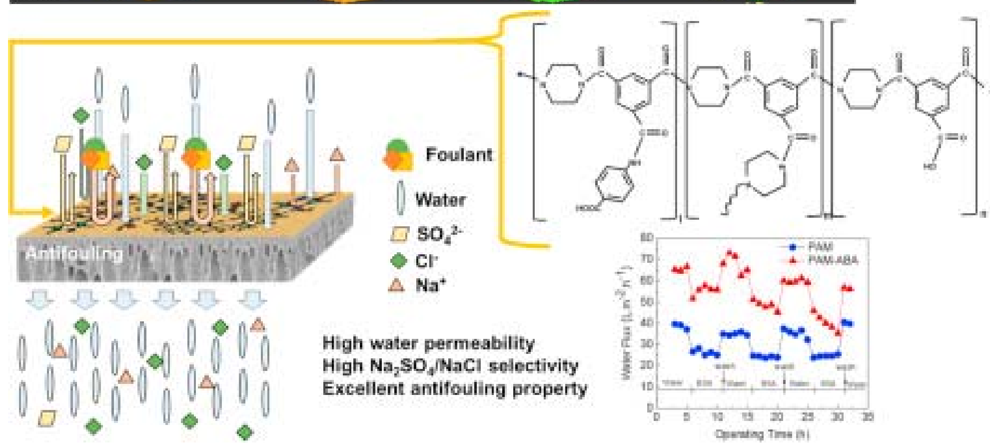
"Methods" TOC


Mesoporous TiO2
Normal Spinning Coating
CdSe QDs Seed-Mediated Method
CH3NH3PbI3 Crystal
CdSe
TiO2
Spiro
FTO
E/eV
FTO TiO2 CdSe CH3NH3PbI3 Spiro Au

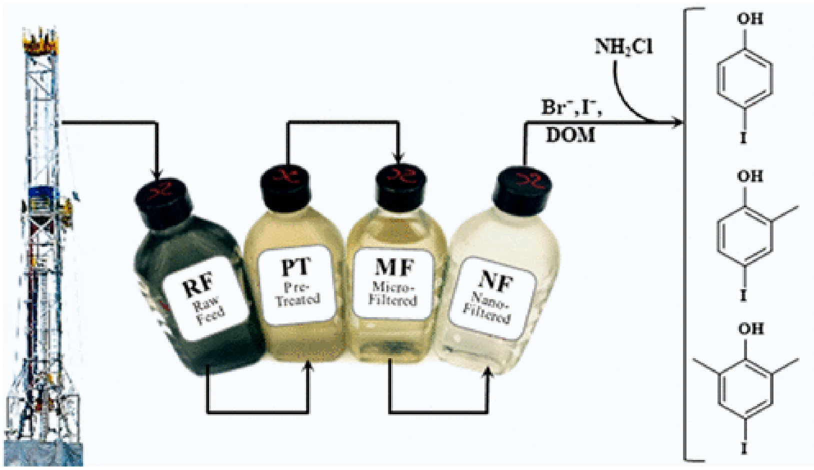

ACT
9.8 sec (activation at -10°C)

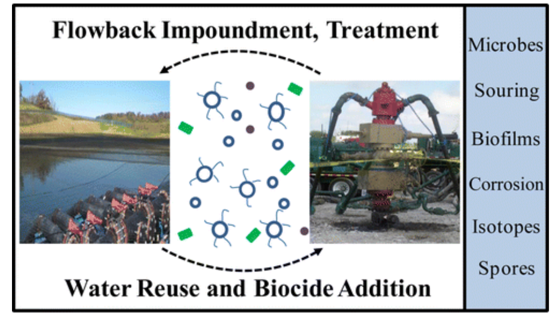

Attenuation
D10
D5
DC10
DC5
V2O5/separator interface
V2O5/separator interface
1 mm

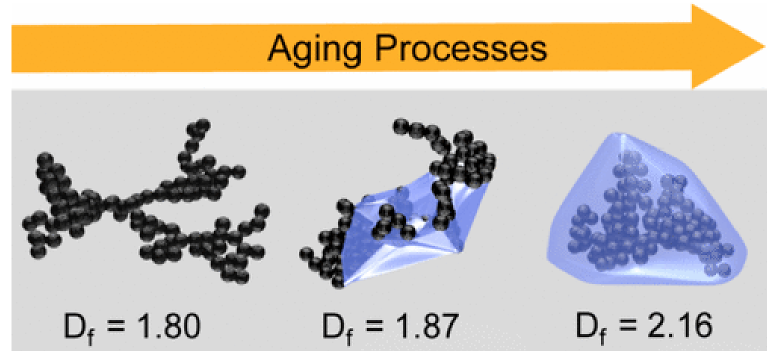

Self-assembling
Crosslinking
Micro-phase separation
Backbone
Side chain
Swelling
Cationic group
Water

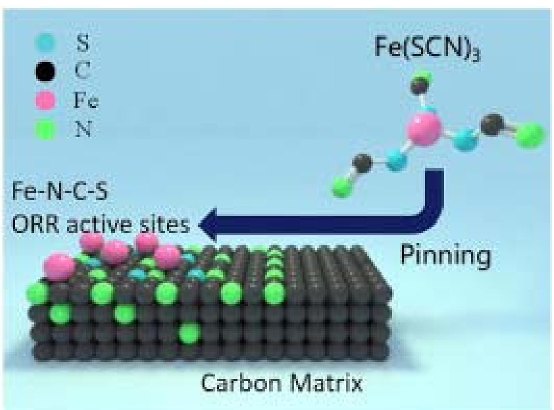

Foulant
Water
SO4 2-
Cl-
Na+
Antifouling
High water permeability
High Na2SO4/NaCl selectivity
Excellent antifouling property
PAM
PAM-ABA
Operating Time (h)

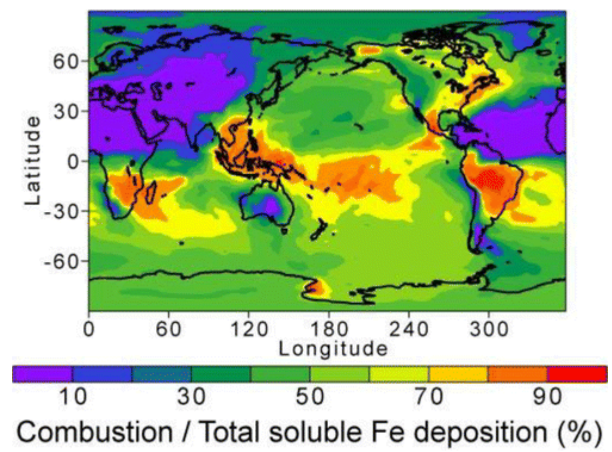
What makes a good TOC?











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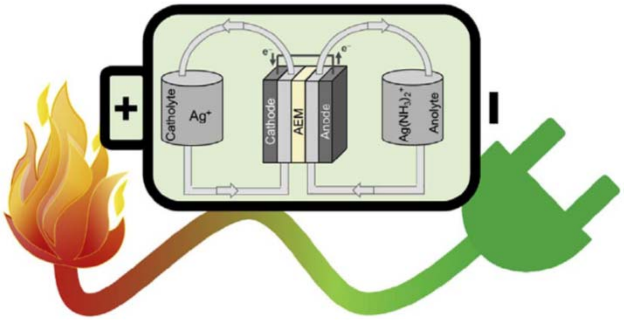
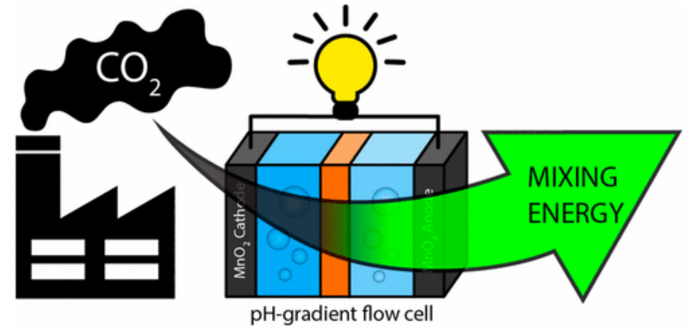
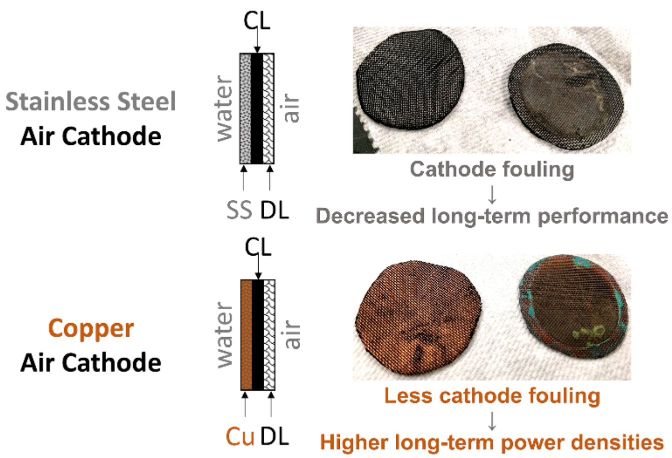
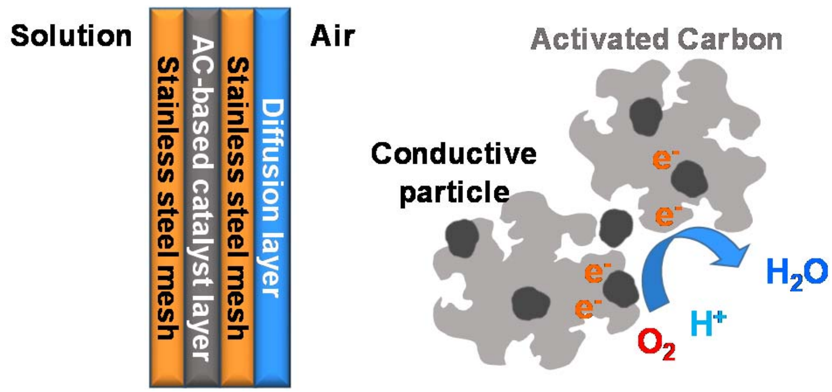
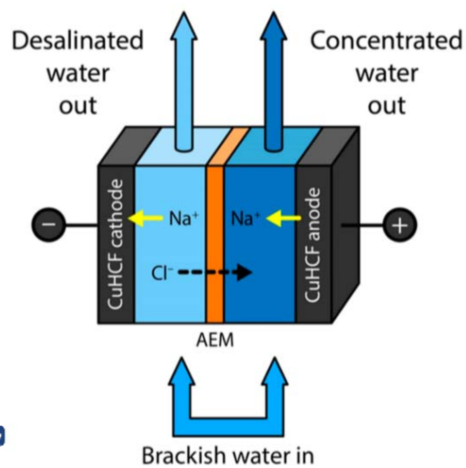
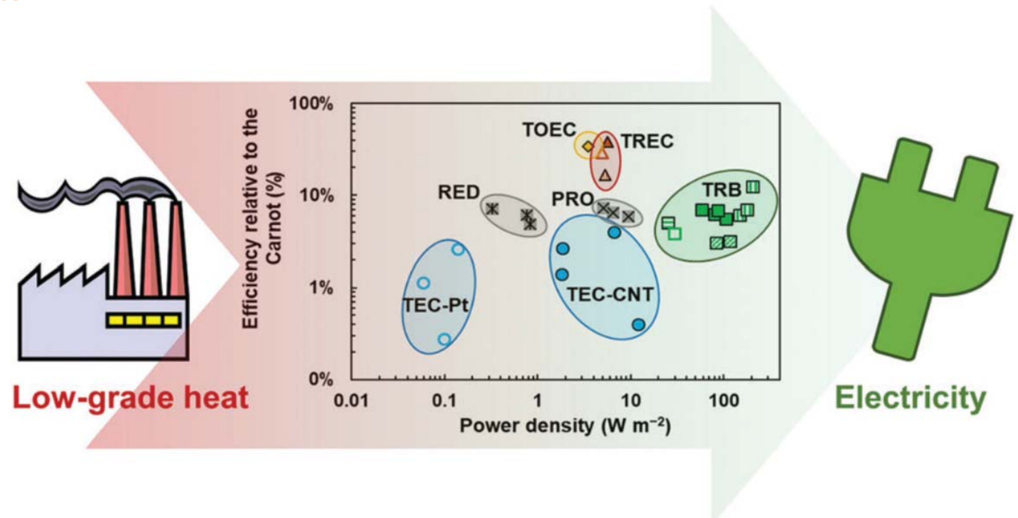

Catholyte
Ag+
Cathode
AEM
Anode
Anolyte


CO_2
MIXING ENERGY
pH-gradient flow cell


Stainless Steel
Air Cathode
CL
water
air
SS DL
Cathode fouling
Decreased long-term performance
Copper
Air Cathode
CL
water
air
Cu DL
Less cathode fouling
Higher long-term power densities


Solution
Air
Stainless steel mesh
AC-based catalyst layer
Stainless steel mesh
Diffusion layer
Activated Carbon
Conductive particle
e-
H_2O
H^+
O_2


Desalinated water out
Concentrated water out
CuHCF cathode
CuHCF anode
Na^+
Na^+
Cl^-
AEM
Brackish water in


Low-grade heat
Electricity
Efficiency relative to the Carnot (%)
100%
10%
1%
0%
0.01
0.1
1
10
100
Power density (W m⁻²)
TOEC
TREC
RED
PRO
TRB
TEC-Pt
TEC-CNT

Before your presentation

- Check out the room you will present in before your presentation (arrive early)
- View your slides on the computer to make sure fonts and animation work correctly
- Determine microphone and pointer availability (green pointers are needed on some screens)

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Starting your presentation

- If your name and presentation title have just been given, don't repeat them (unless they are incorrect)
- If you are nervous, memorize your first two sentences… after that, it gets easier!
- Adjust your explanation of material based on previous presenters (if they just explained how an MFC works, don't spend much time on it)

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Speaking pointers

- Look at your audience
- Talk to the audience, not the projector screen behind you.
- If you are a the podium, use the laptop screen as your "teleprompter" as it is in front of you.

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When using a microphone

- Keep a constant distance to the podium microphone
- If using a mobile microphone, don’t change your voice direction relative to the location of the microphone
- Put the microphone on the side that is closest to the projector screen

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Organizing material on a slide

- Don’t put important information at the bottom of a slide
  - The bottom is typically the hardest part to see, especially in a crowded room.
- - If you put something on a slide, discuss and explain it.
  - If it’s not worth discussing, it’s not worth putting on the slide.
- Try to have one “idea” per slide.

Very important

The main conclusion is:
The ohmic resistance

Make the point of your slide clear, so that the slide is understood even if the audience has trouble understanding your “English”

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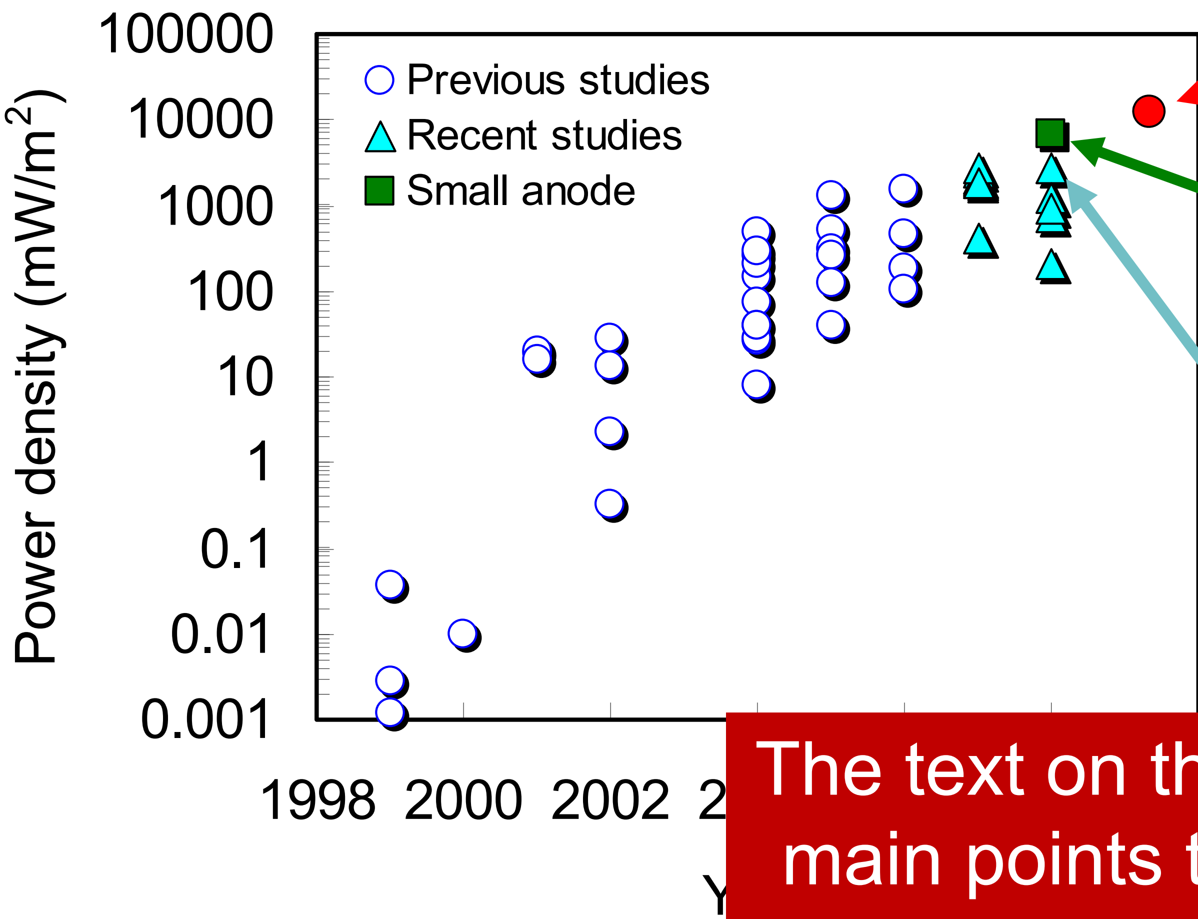
Power production in MFCs worldwide under optimal conditions (only oxygen cathodes)



- Maximum estimated to be **17 W/m²**

- **6860 mW/m²** (Anode 1/14th the size of the cathode) = 490 mW/m² based on cathode size

-**2700 mW/m²** (equally sized electrodes)

The text on the right makes the main points that we are trying to show in the graph

Logan (2008) *Nature Microbiol.*

When answering questions

- Don't rush into an explanation… think for a few moments. It is okay.
- If the questions may not be clear to others, restate the question. This can also help you to focus on the main points.
- Putting slide numbers on your slides helps people to ask about specific slides

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Be sure to acknowledge colleagues and funding sources

You might want your final slide to have your contact information (email address or websites)

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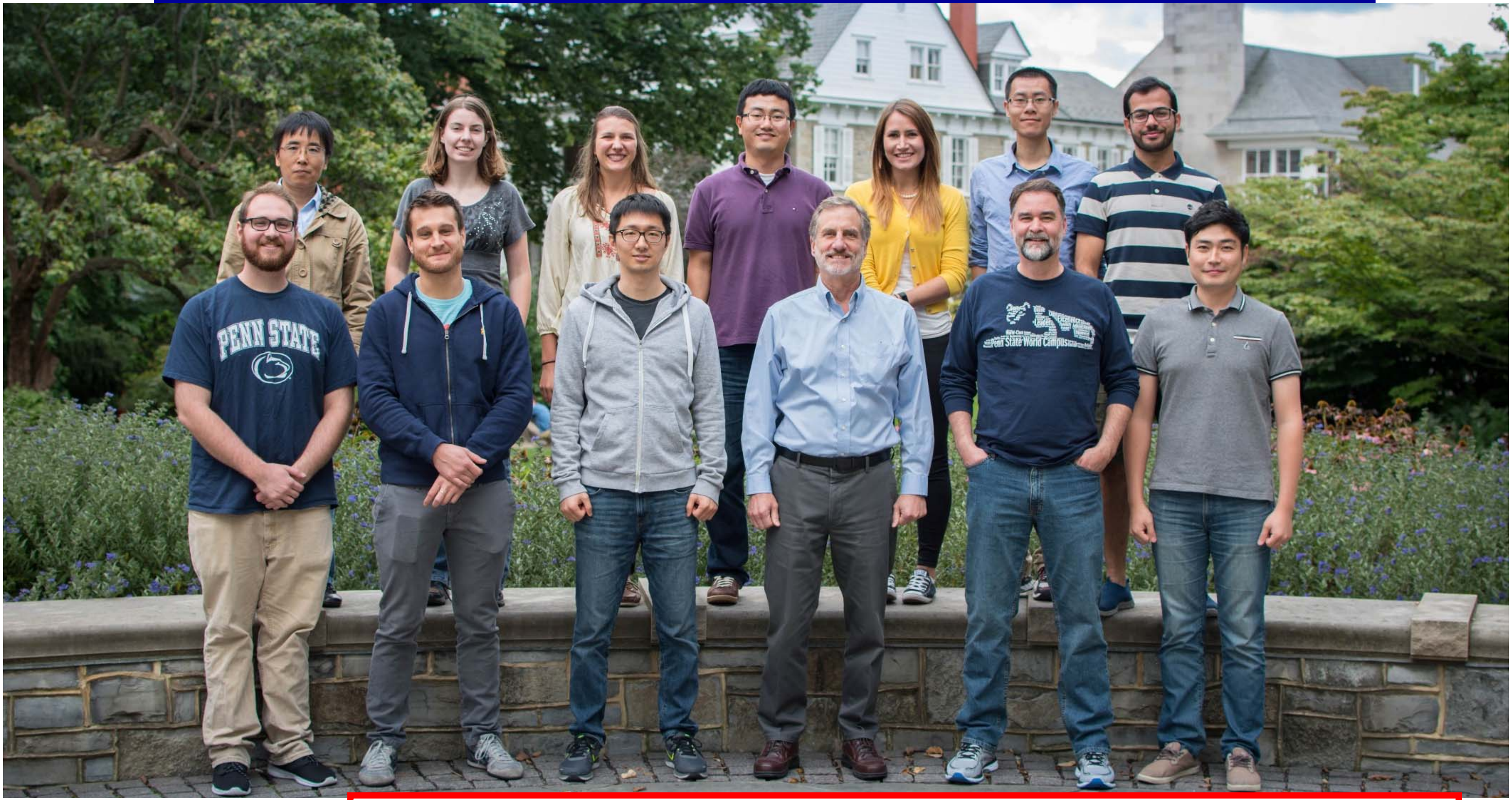
Thanks to students and researchers at Penn State! (2017)



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NREL/DOE (2014-2017); KAUST (2015-2017); SERDP (2013-2016);
Penn State: Stan and Flora Kappe Professorship