Supporting Information

Coupling Enzymes and Inorganic Piezoelectric Materials for Electricity Production from Renewable Fuels

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Table S1. Gas-producing enzymes triggering bubbling effect

Enzymes	Substrates	Produced gas	Bubbling
CAT	H_2O_2	O_2	Positive
GOX/CAT	Glucose	O_2	Negative
GOX/CAT	Glucose and H_2O_2	O_2	Positive
Urease/CA	Urea	CO_2	Negative
CA	Bicarbonate	CO_2	Negative
FDH/AlaDH	Formate, NAD^+, NH_4Cl, pyruvate	CO_2	Negative
ADH/FDH	Acetone, NAD^+	CO_2	Negative
AOX/CAT	Ethanol	O_2	Negative
AOX/CAT	Ethanol and H_2O_2	O_2	Positive
DAO/CAT	*D*-Alanine	O_2	Negative
DAO/CAT	*D*-Alanine and H_2O_2	O_2	Positive
LAO /CAT	*L*-Phenylalanine	O_2	Negative
LAO /CAT	*L*-Phenylalanine and H_2O_2	O_2	Positive

CAT: Catalase, GOX: Glucose oxidase, CA: Carbonic anhydrase, FDH: formate dehydrogenase, AlaDH: alanine dehydrogenase, ADH: alcohol dehydrogenase, AOX: alcohol oxidase, DAO: *D*-amino acid oxidase and LAO: *L*-amino acid oxidase.

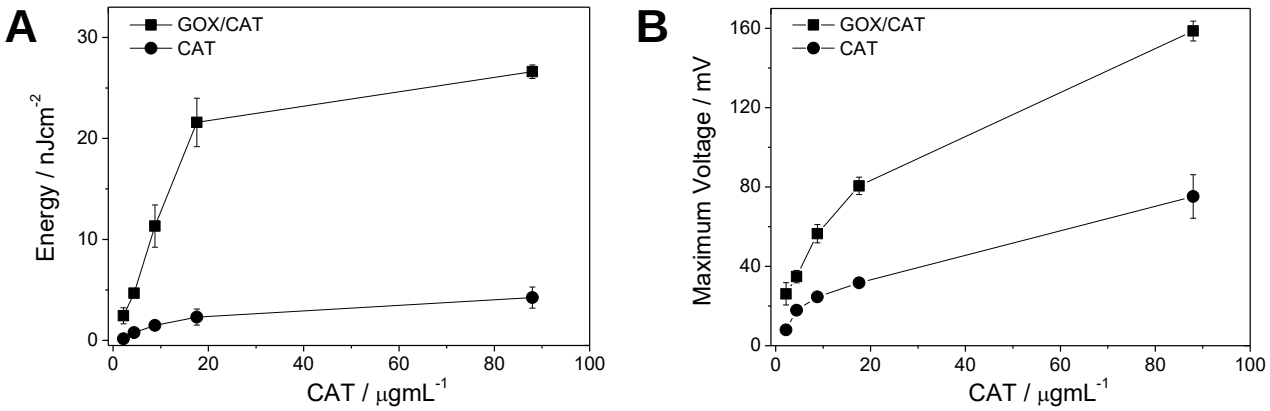

Figure S1. Effect of different CAT concentrations in the produced energy (A) and maximum voltage (B) by OBIG when the system is composed only by CAT (circles) and by the two enzymes GOX/CAT (squares). In all cases the reaction mixture was composed by CAT or GOX/CAT (GOX at 0.75 mg•mL^{-1}), 100 mM glucose and 50 mM H_2O_2 in 50 mM phosphate buffer pH 7.5 at 25ºC.

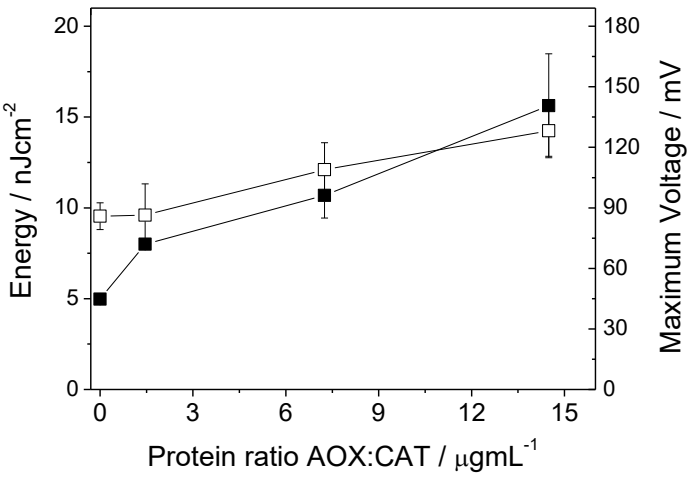

Figure S2. Effect of different enzymatic activity ratios in the produced energy (black squares) and maximum voltage (white squares) by the AOX/CAT-OBIG. In all cases the reaction mixture (total volume of 400 µL) was composed by CAT and AOX, 100 mM ethanol; and 50 mM H_2O_2 in 50 mM phosphate buffer pH 7.5 at 25ºC.

Table S2. Kinetic parameters of different oxidases

Enzyme	Substrate	Substrate Km (mM)	Oxygen Km (mM)	H_2O_2 inhibition (mM)
GOX	Glucose	25[1]	0.2[2]	≈ 0.2[3]
AOX	Ethanol	2.7[4]	0.4[2]	0.92[4]
LAO	*L*-phenylalanine	37.8[5]	nr	nr
DAO	*D*-alanine	7.0[6]	0.18[2]	36[6]

GOX: gluxose oxidase, AOX: alcohol oxidase, LAO: *L*-amino acid oxidase, DAO: *D*-amino acid oxidase. nr: Not reported.

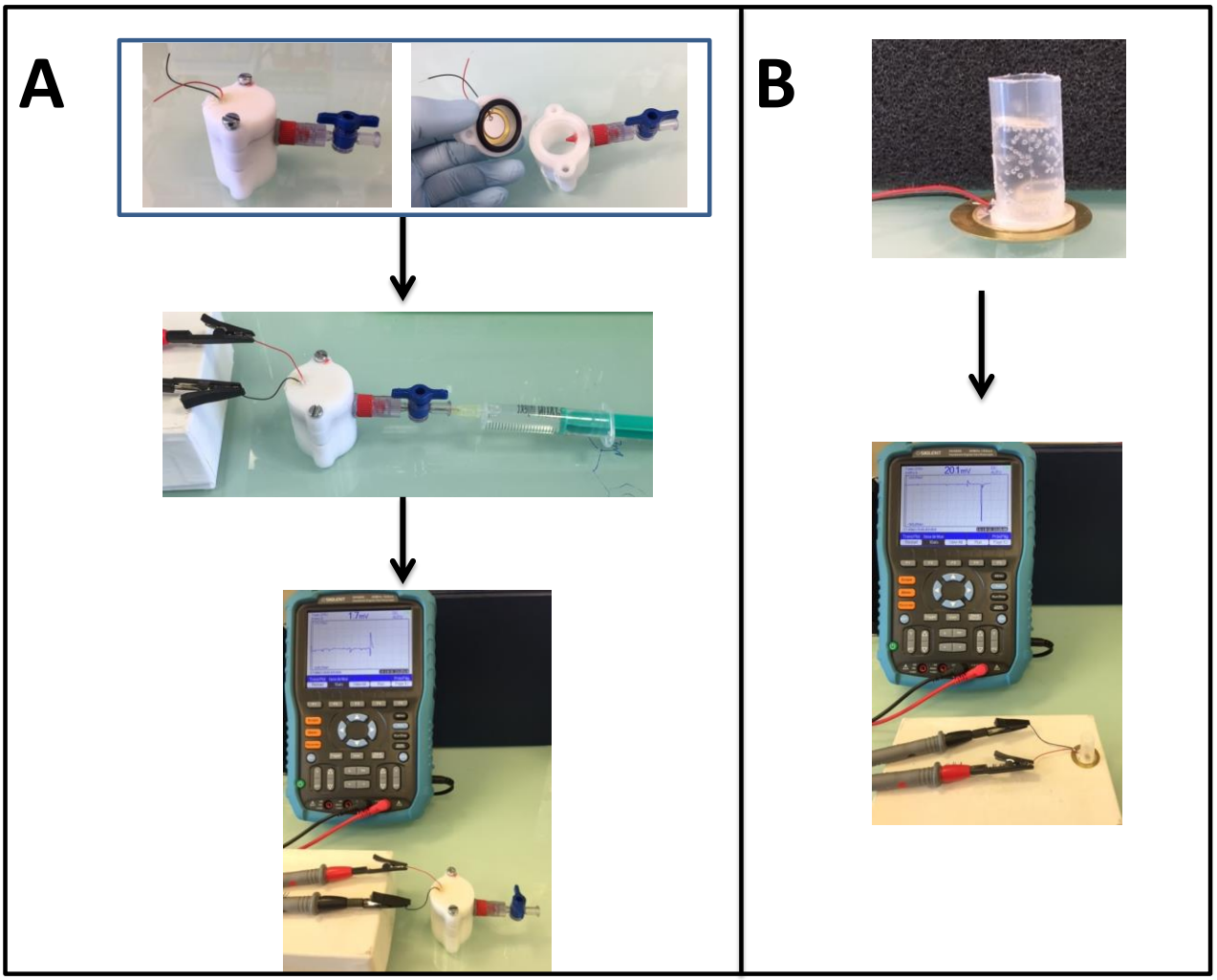

Figure S3. Bioinorganic generators connected to an oscilloscope. A: Closed system bioinorganic generator (CBIG). B) Open system bioinorganic generator (OBIG).

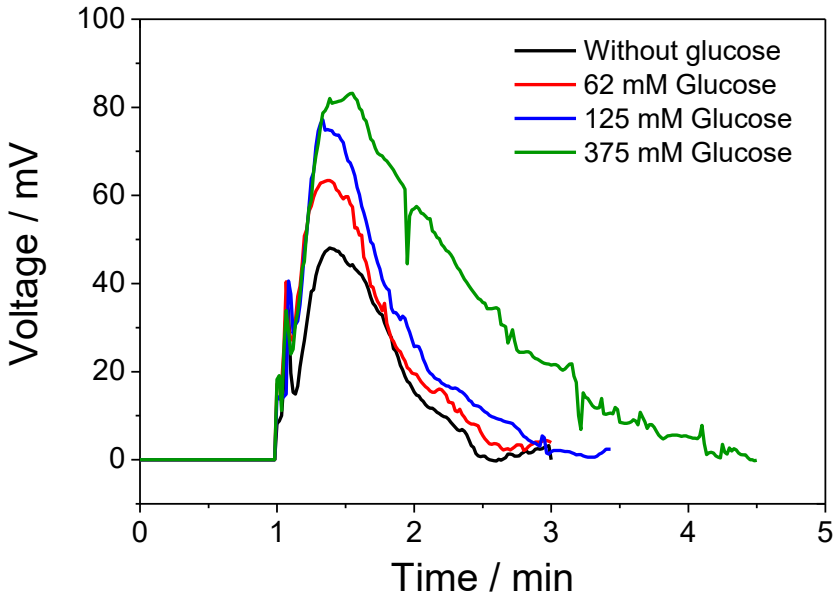

Figure S4. Effect of glucose concentration in the produced energy by the GOX/CAT-OBIG. In all cases the reaction mixture was composed by CAT (88 µg•mL^{-1}) and GOX (0.38 mg•mL^{-1}), glucose (as indicated) and 50 mM H_2O_2 in 50 mM phosphate buffer pH 7.5 at 25ºC.

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