Electronic Supplementary Material (ESI) for Reaction Chemistry & Engineering.

Formation of Syngas from Carbon Dioxide, Hydrogen Sulfide and Water

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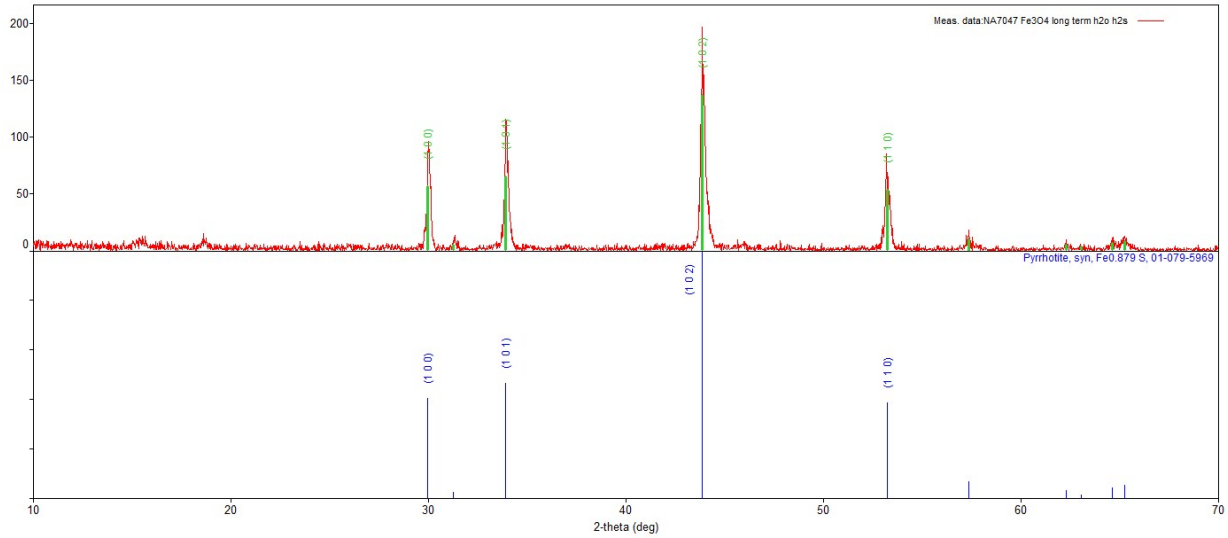
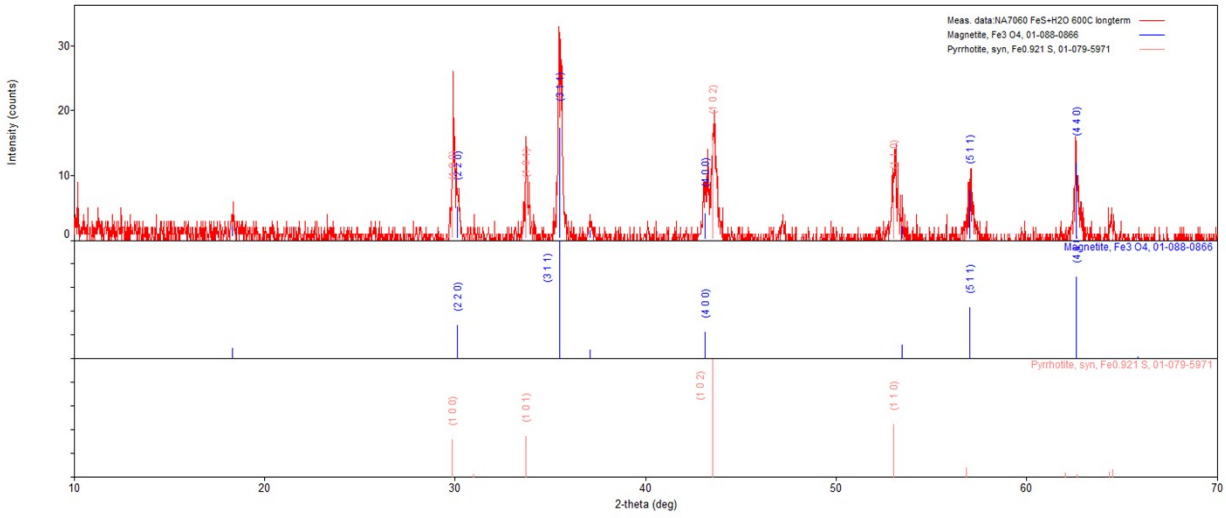
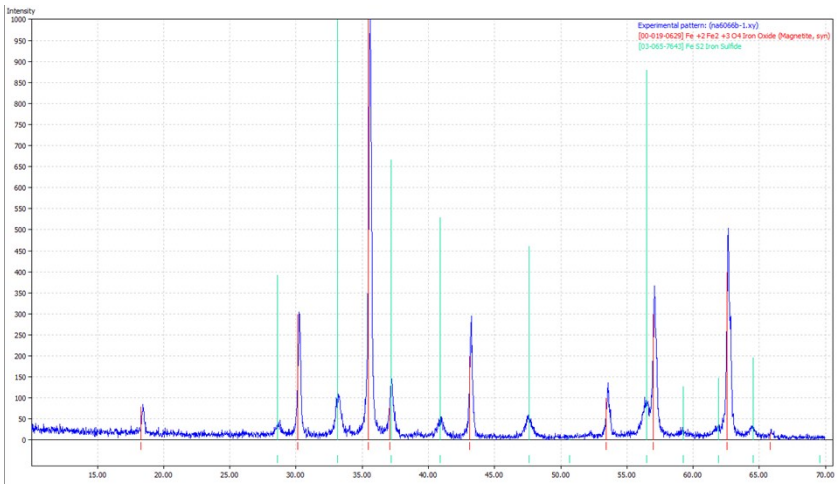
Production of Hydrogen



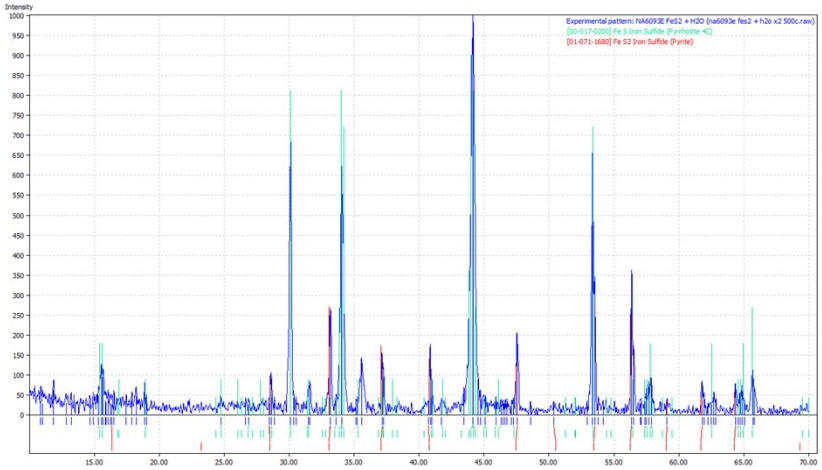
Supplementary Figure 1- XRD pattern of FeS + H_2S + H_2O after 7 hours reaction



Supplementary Figure 2- XRD pattern of FeS + H_2O after 5 hours reaction



Supplementary Figure 3- XRD pattern of Fe_3O_4 reacting with elemental sulfur at 400°C after an hour reaction.



Supplementary Figure 4- XRD pattern of the reaction of FeS_2 with H_2O at 500°C after 2 hours

Supplementary Table 1 - Hydrogen production rate from the reactions in figure 7

FeS (mmol)	**S (mmol)**	**SO_2 (mmol)**
2	< 0.3	0.4
5	< 0.3	0.5
7	< 0.3	0.1

Supplementary Table 2 - Hydrogen production rate from the reactions in figure 8

Flow (mL/H)	**S (mmol)**	**SO_2 (mmol)**	**H_2 rate (mmol/$g_{catalyst}$/min)**
600	< 0.3	0.5	0.0161
1800	< 0.3	0.5	0.0161
3000	0	0.6	0.0144

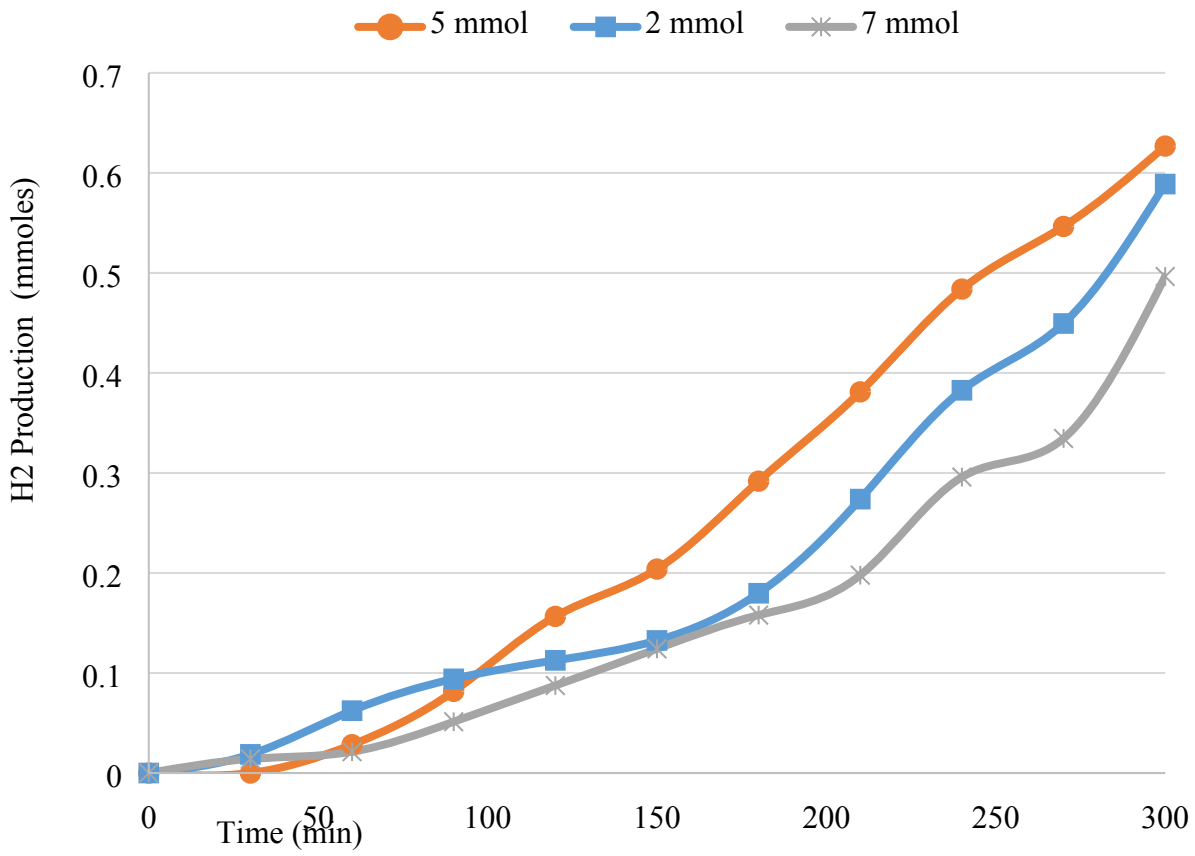
Supplementary Table 3 - Hydrogen production rate from the reactions in figure 11

H_2O Temp (°C)	**S (mmol)**	**SO_2 (mmol)**	**H_2 rate (mmol/$g_{catalyst}$/min)**
Room temperature	< 0.3	0.09	0.0092
60	< 0.3	0.03	0.0167
85	< 0.3	0.5	0.0161
100	< 0.3	0.16	0.0188

Supplementary Table 4 - Hydrogen production rate from the reactions in figure 12

Temp (°C)	**S (mmol)**	**SO_2 (mmol)**	**H_2 rate (mmol/$g_{catalyst}$/min)**
600	< 0.3	0.5	0.0161
700	0.64	0.1	0.0251
800	0.91	0.2	0.0307
900	1.28	0.2	0.0513

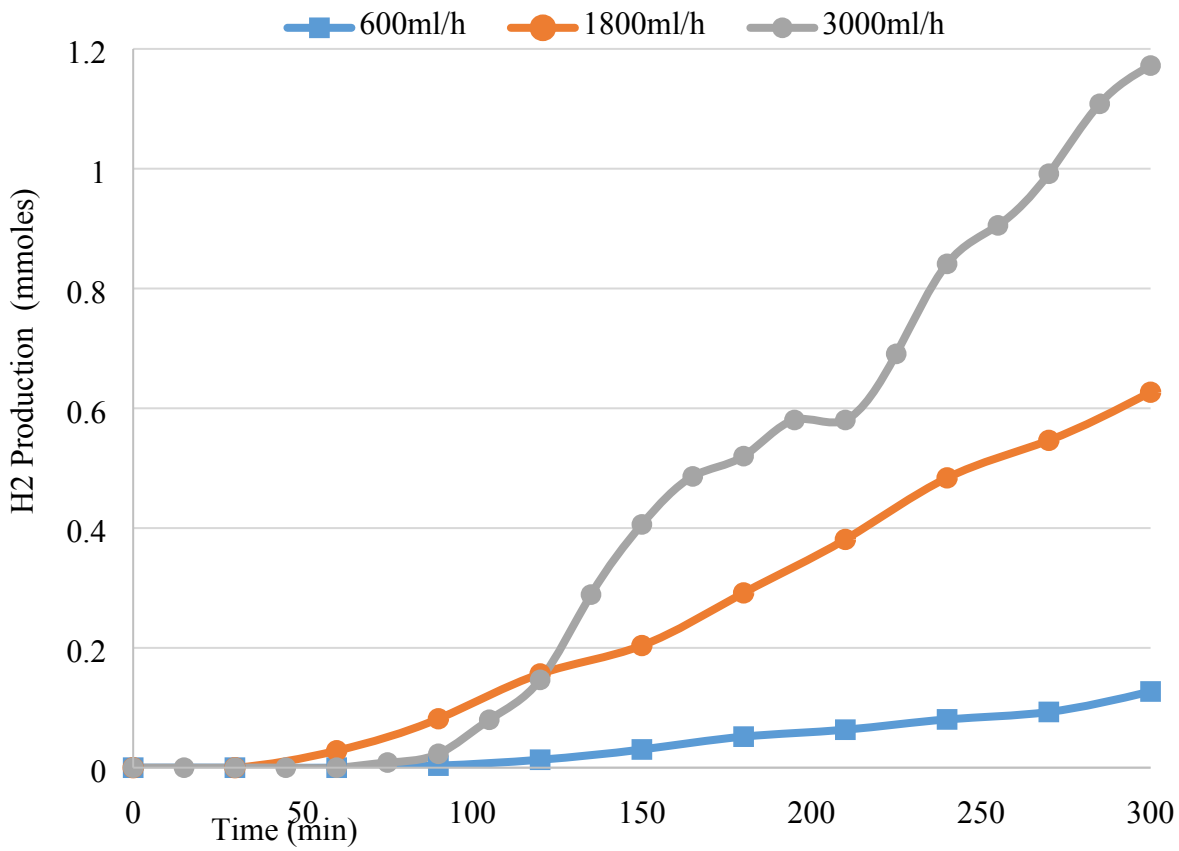
Experiments performed starting from Fe_3O_4. The catalyst loading and gas flow were investigated.



Supplementary Figure 5 - Hydrogen production from different iron oxide loadings in the tube furnace reaction

Supplementary Table 5 - Hydrogen production rate from the reactions in figure 9

Fe_3O_4 (mmol)	S (mmol)	SO_2 (mmol)	H_2 rate (mmol/$g_{catalyst}$/min)
2	< 0.3	0.05	0.0042
5	0.8	0.2	0.0018
7	< 0.3	0.07	0.0010

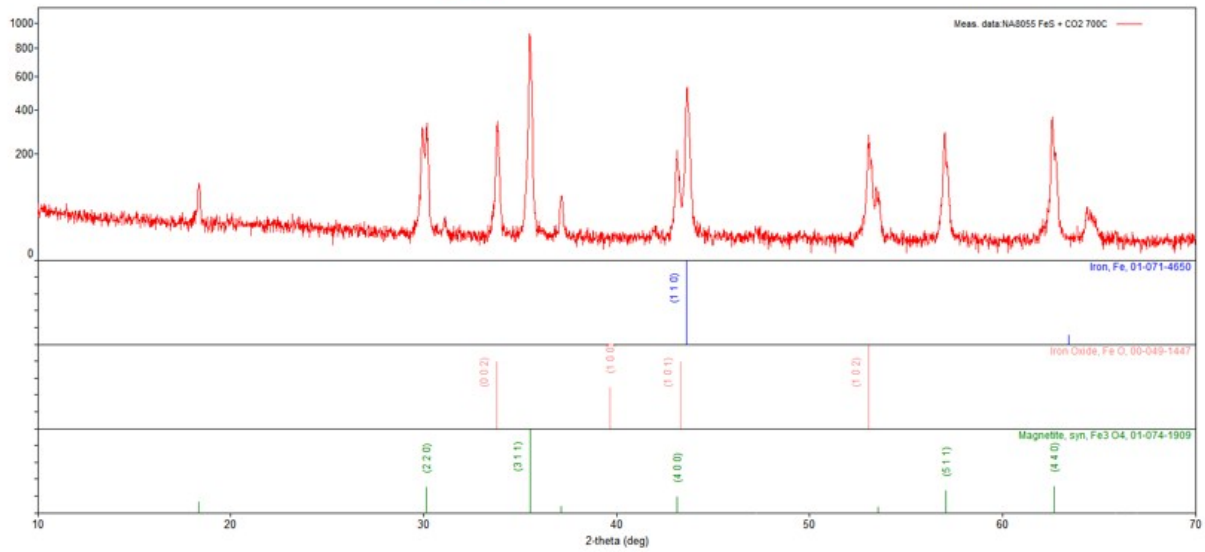


Supplementary Figure 6 - Hydrogen production from iron oxide in the tube furnace reaction using various gas flows

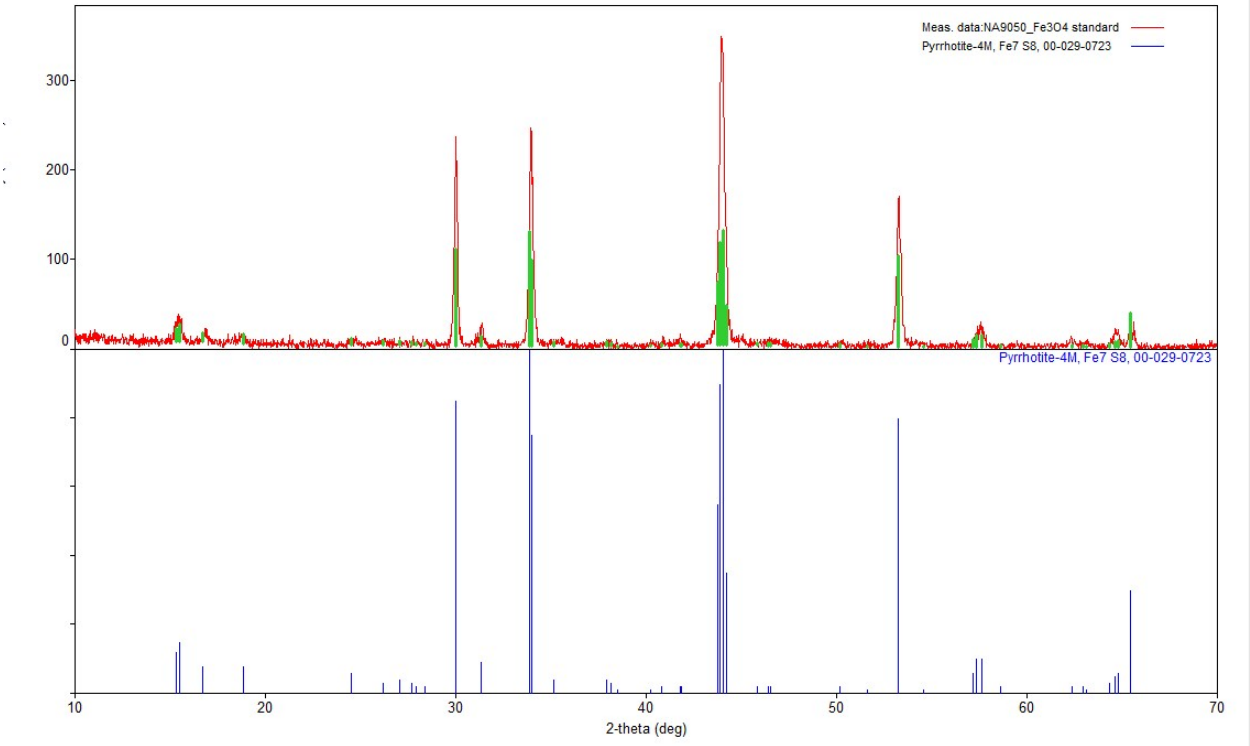
Supplementary Table 6 - Hydrogen production rate from the reactions in figure 10

Flow (mL/H)	**S (mmol)**	**SO_2 (mmol)**	**H_2 rate ($mmol/g_{catalyst}/min$)**
600	< 0.3	0.3	0.0004
1800	0.8	0.2	0.0018
3000	< 0.3	0.4	0.0034

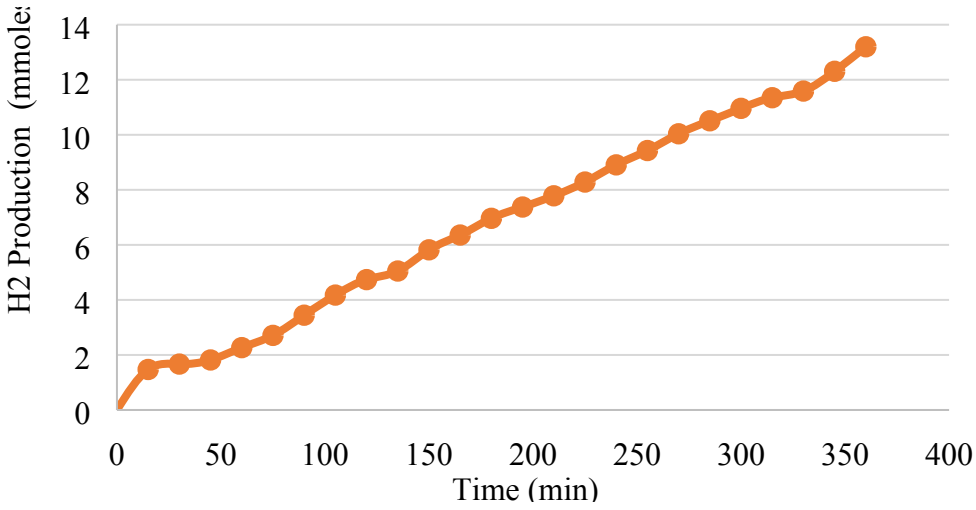
FeS + CO2



Supplementary Figure 7 – Products from the reaction FeS + CO_2 at 600°C for 5 hours



Supplementary Figure 8 – Products from the reaction Fe_3O_4 + H_2S at 600°C for 1 hour



Supplementary Figure 9 – Production of Hydrogen from the best reaction conditions for FeS (5 mmoles of iron sulfide, 12% H_2S in Ar with a total flow of 1800ml/H, Ar was flowing through an 85°C water and the reaction temperature was 900°C)

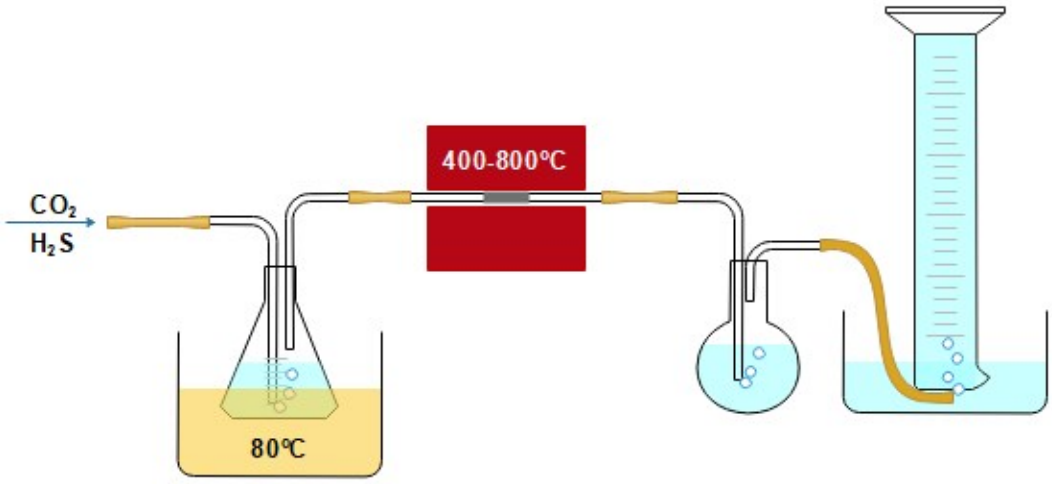
Supplementary Table 7 – Total amounts of reagents used and products formed from Figure 15 after 120 hours reaction

Time	Total CO_2 injected (mmoles)	Total H_2S injected (mmoles)	H_2 formation (mmoles)	CO formation (mmoles)	SO_2 formation (mmoles)	S formation (mmoles)
40	1071.4	107.1	49.2	28.9	0.3	63.3
80	2142.9	214.3	99.4	40.2	0.60	125.4
120	3214.3	321.4	129.1	50.6	0.97	145.1

Supplementary Table 8 – BET surface area analysis of all catalysts used

Catalyst	Surface area (m^2/g)
FeS (25 mesh)	1.390
FeS (60 mesh)	2.080
FeS (230 mesh)	3.112
FeS (300 mesh)	8.912
FeS (300 mesh, 1 hour reacting)	7.709
FeS (300 mesh, 3 hours reacting)	5.287
FeS (300 mesh, 5 hours reacting)	4.894
WS_2	7.113

MoS_2	9.883
CoS	9.135
NbO_2	7.686
Mn_3O_4	3.263
PbS	3.979
CdS	72.51
V_2O_5	6.046
RuO_2	130.0
NiS	6.219
IrO_2	27.33



Supplementary Figure 10 – Experimental set-up

Supplementary Table 9 – The hydrogen production rates per surface area of FeS (300 mesh) for Figure 13

Time (hrs)	Hydrogen production (mmoles/hr/m^2)
1	0.439
2	0.191
3	0.064
4	0.059
5	0.081