

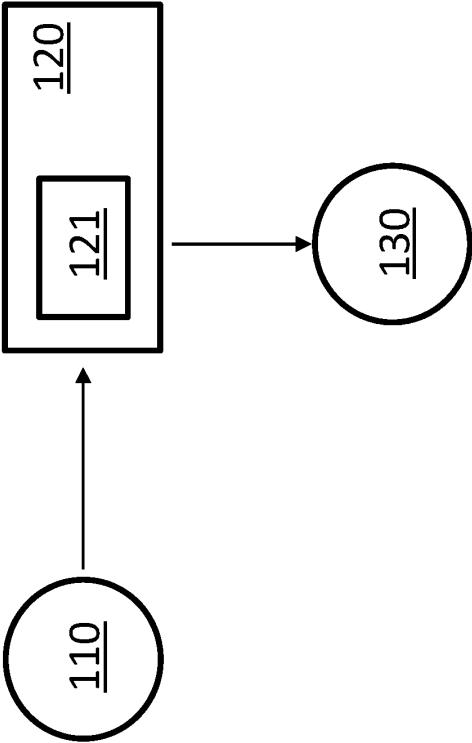


FIG. 1

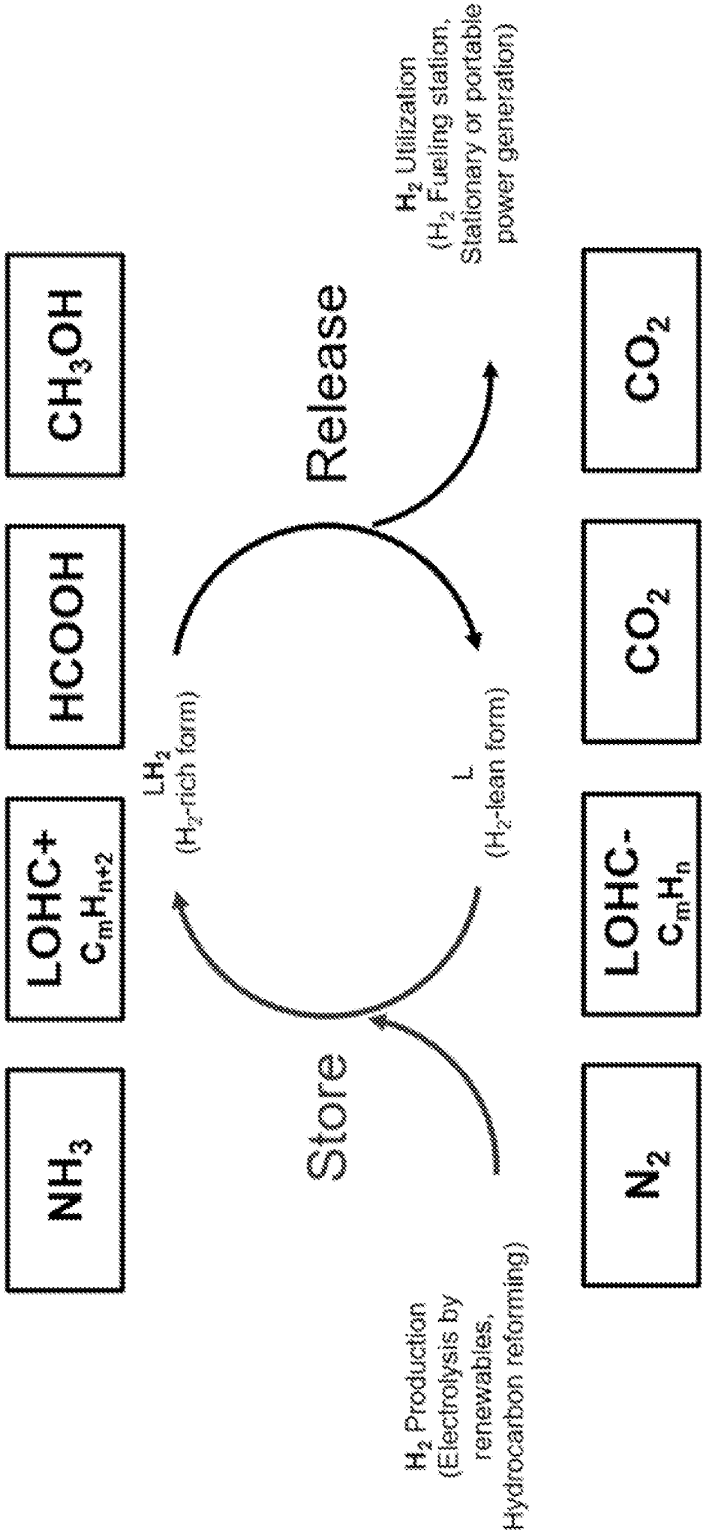


FIG. 2

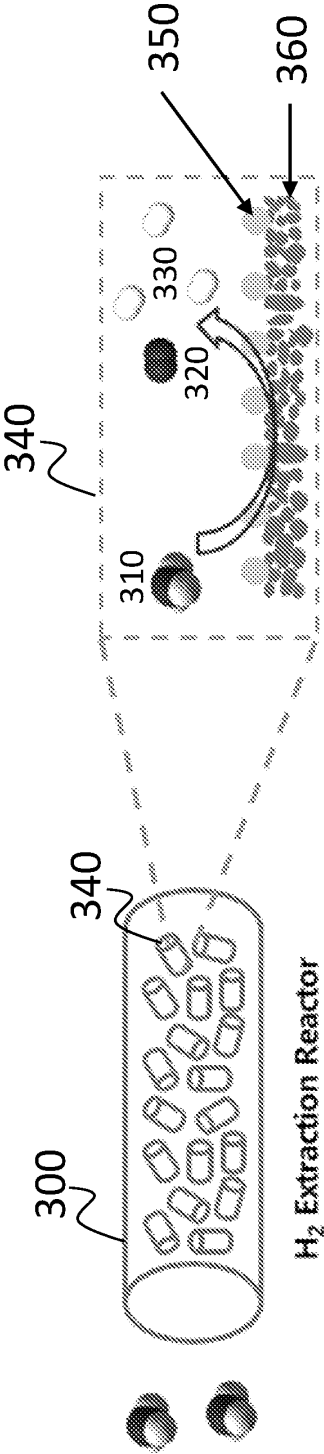


FIG. 3

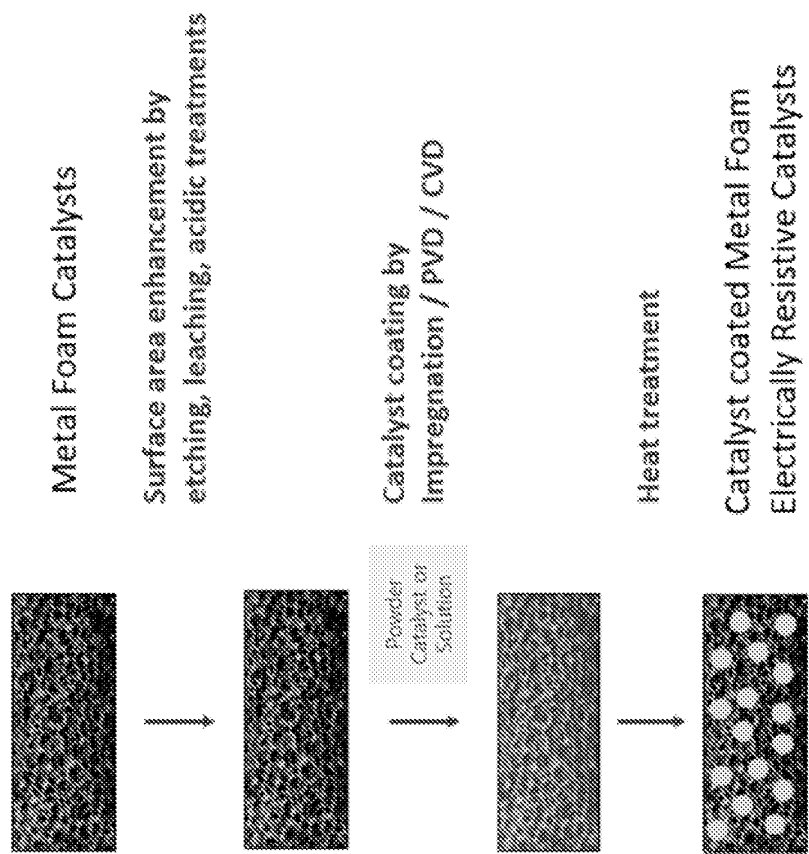


FIG. 4

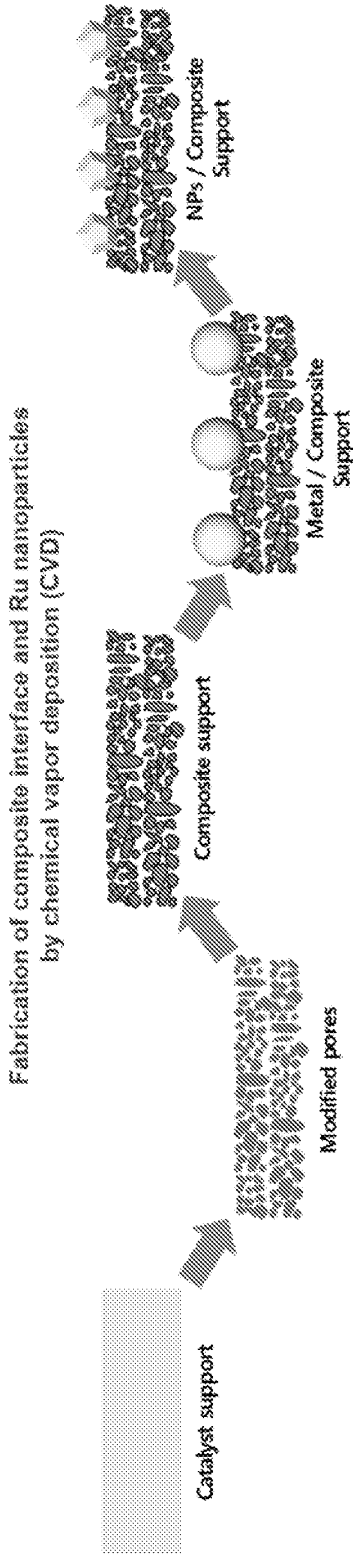


FIG. 5

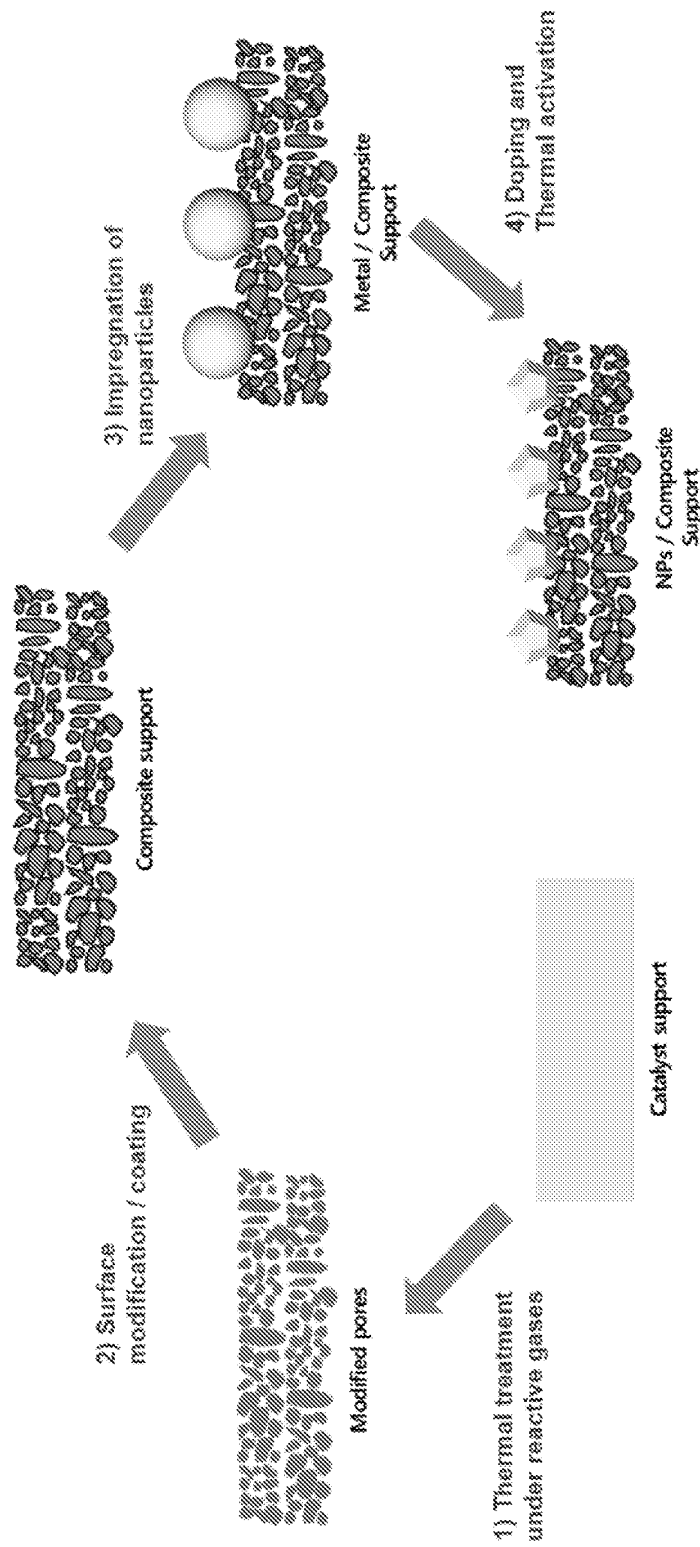


FIG. 6

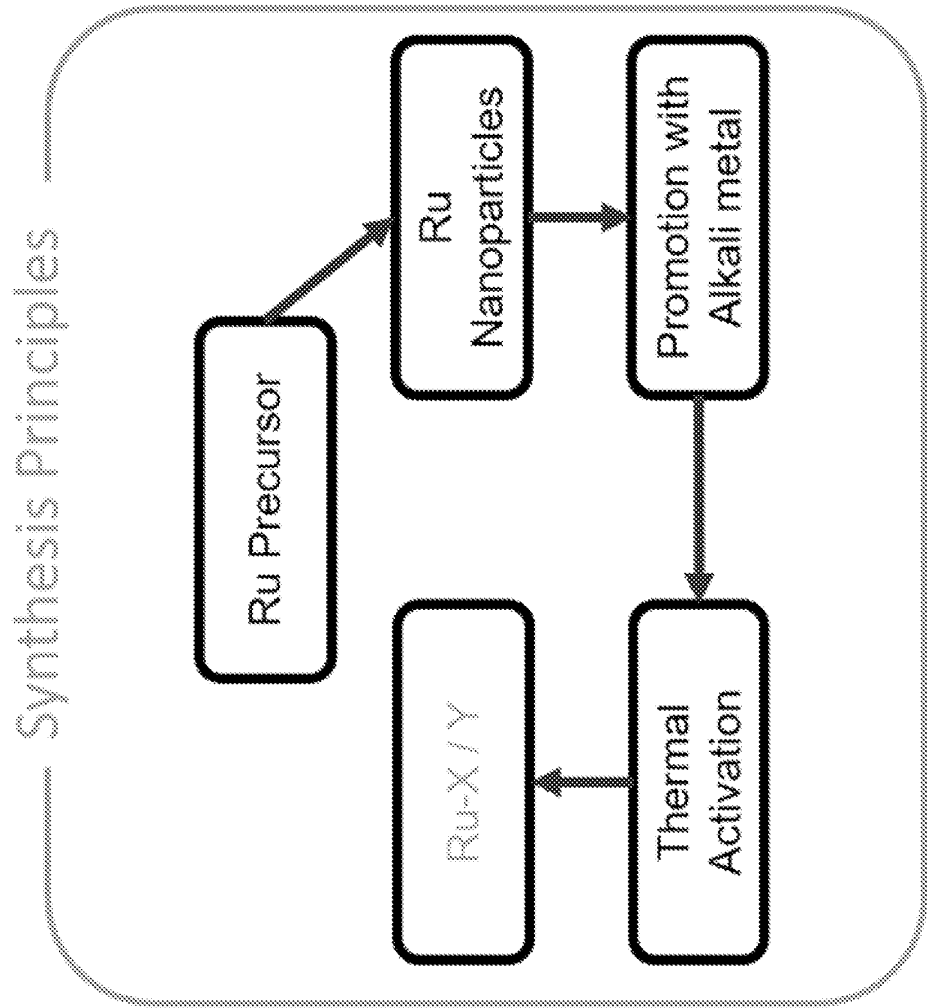


FIG. 7

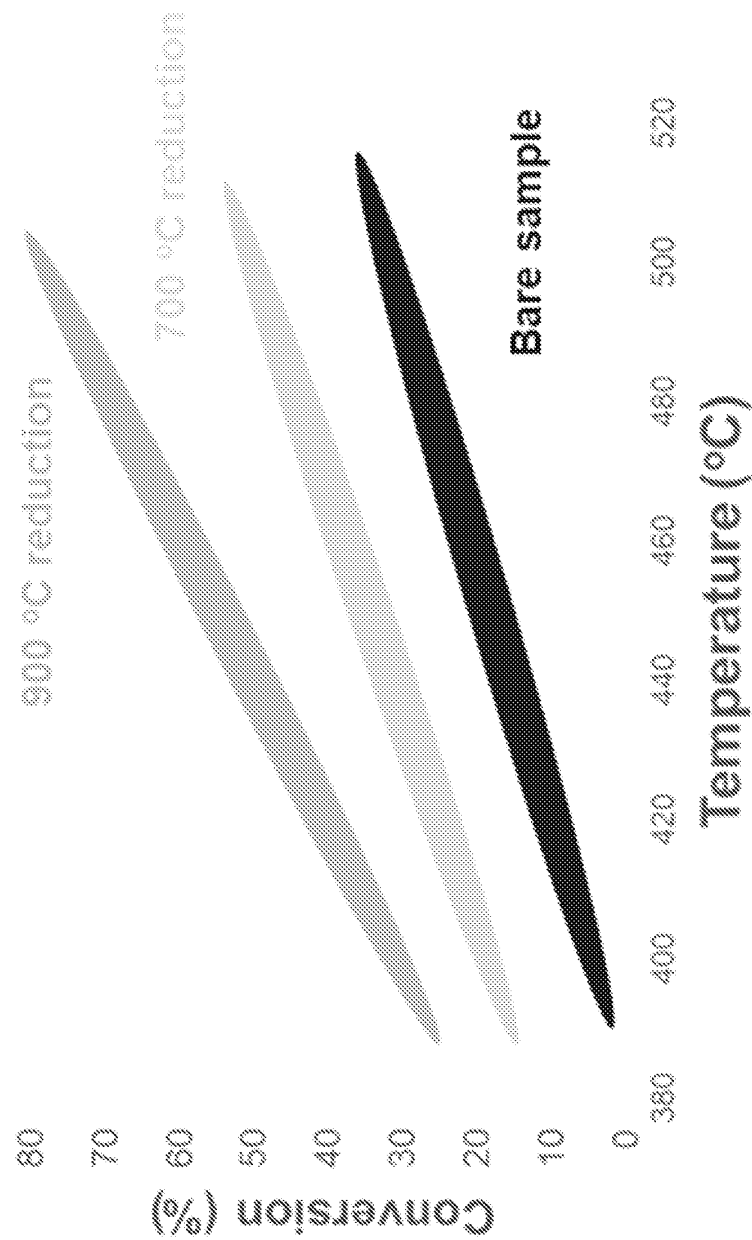


FIG. 8A

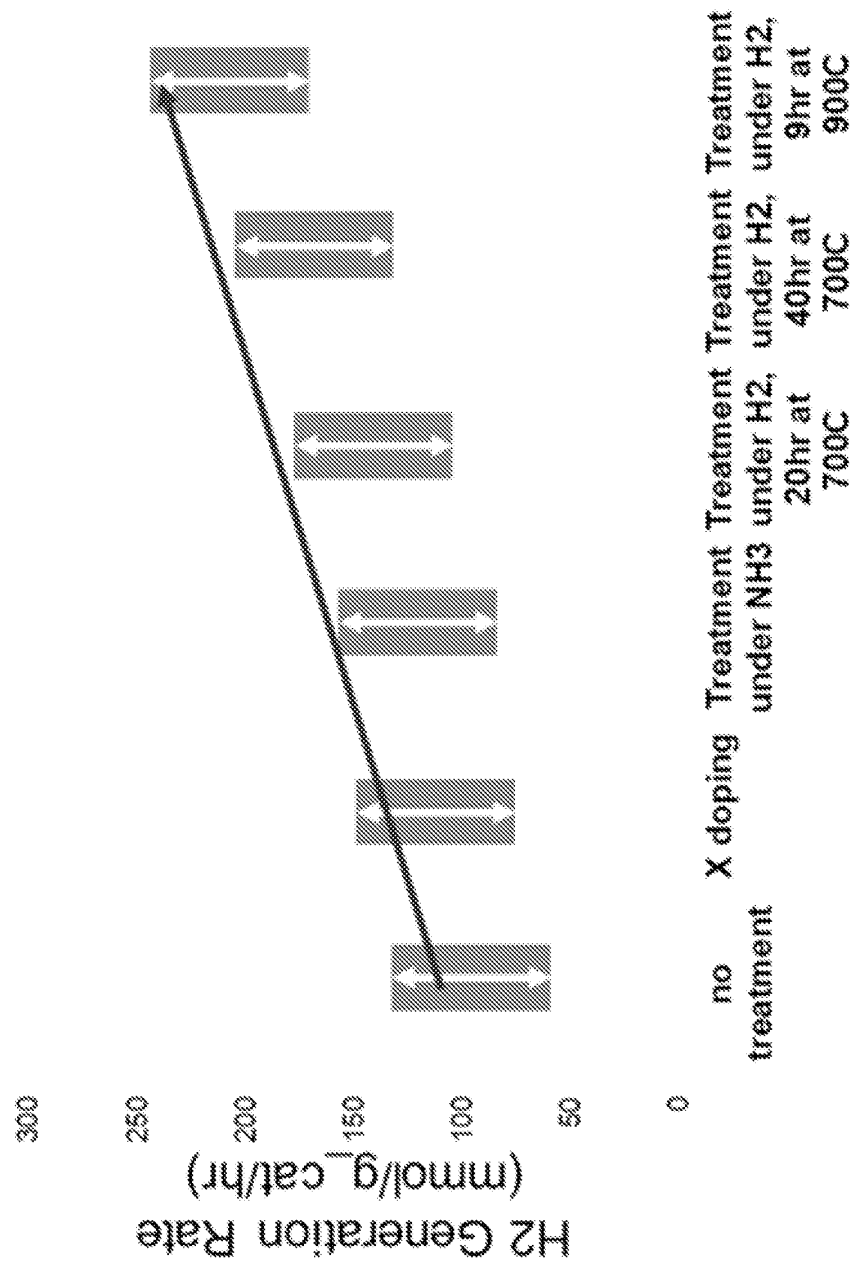


FIG. 8B

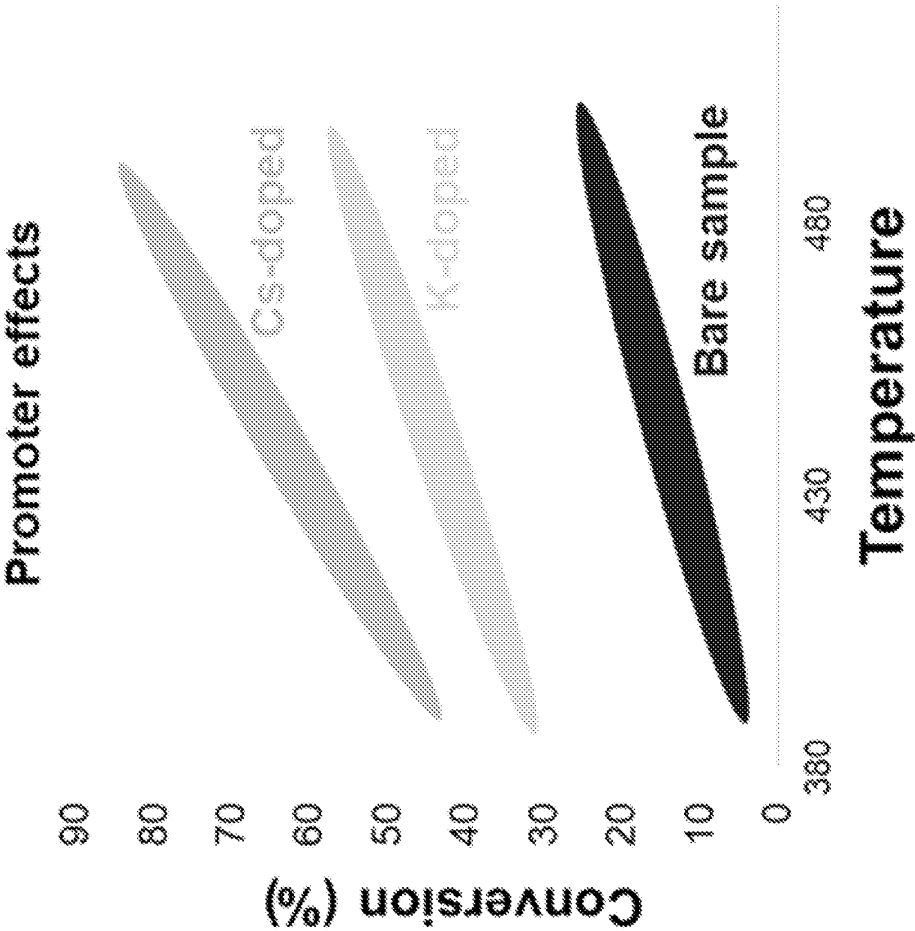


FIG. 8C

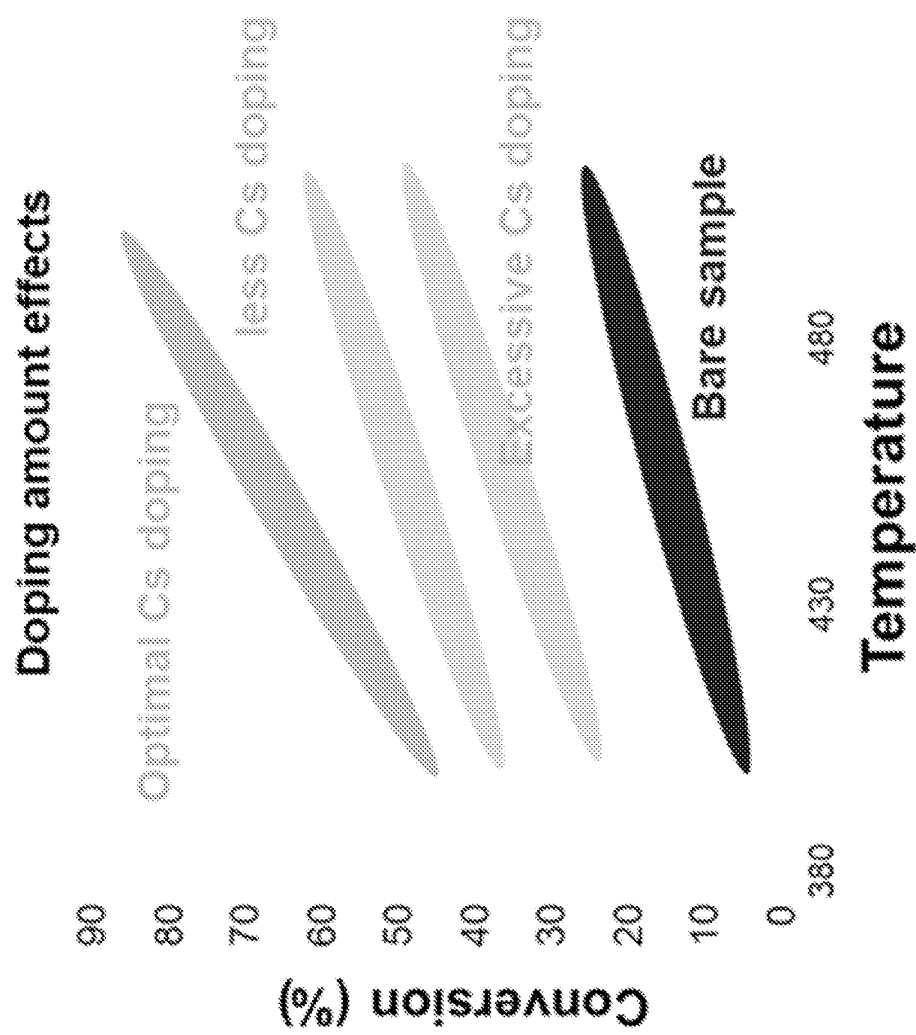


FIG. 8D

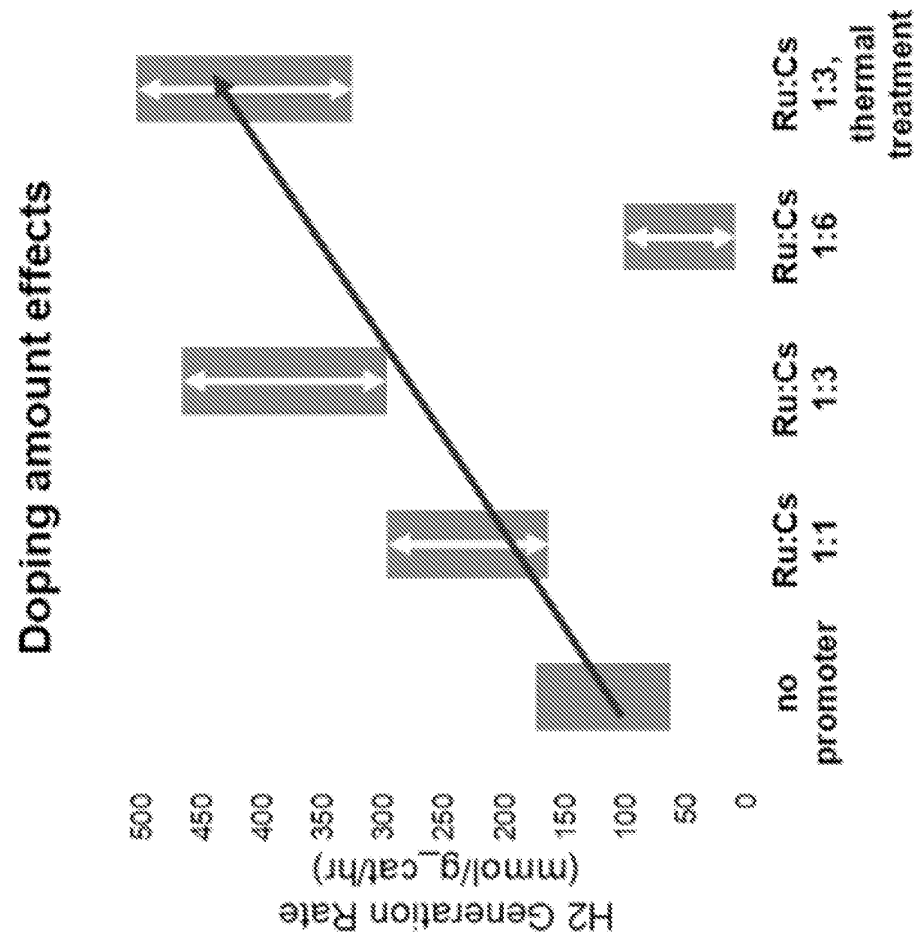


FIG. 8E

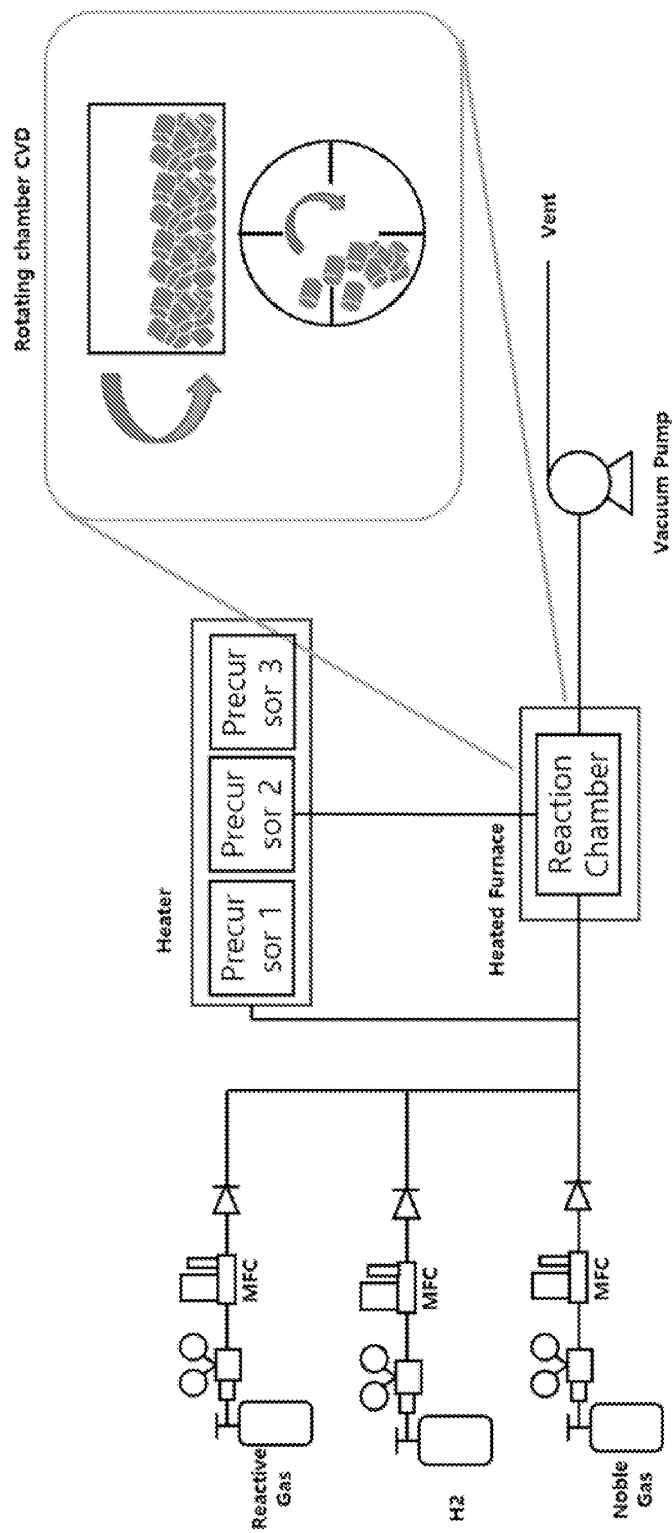


FIG. 9

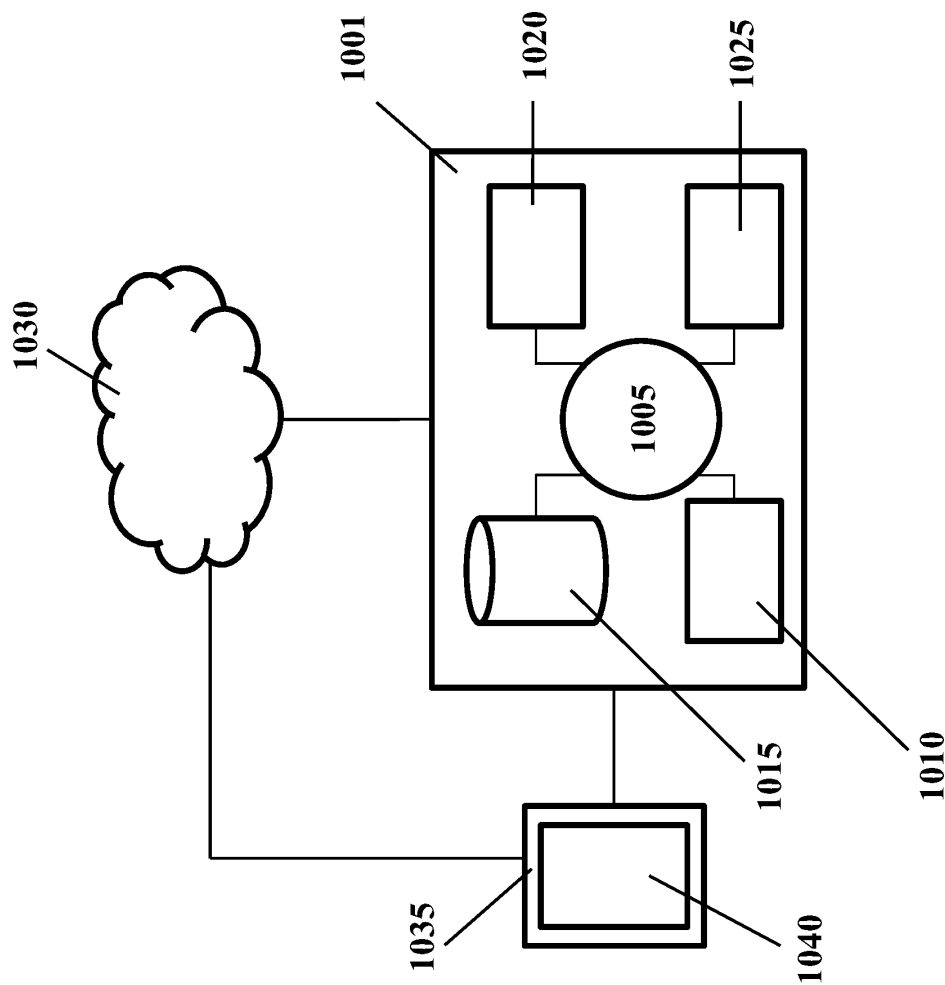


FIG. 10

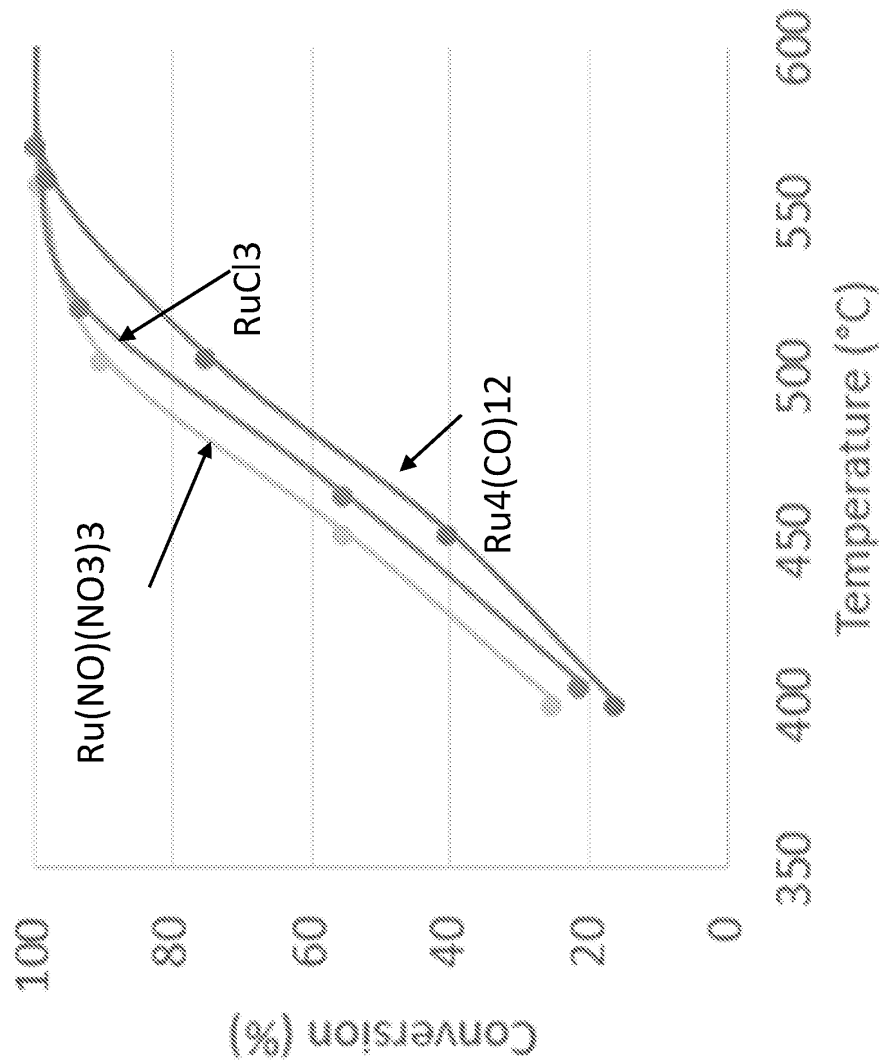


FIG. 11

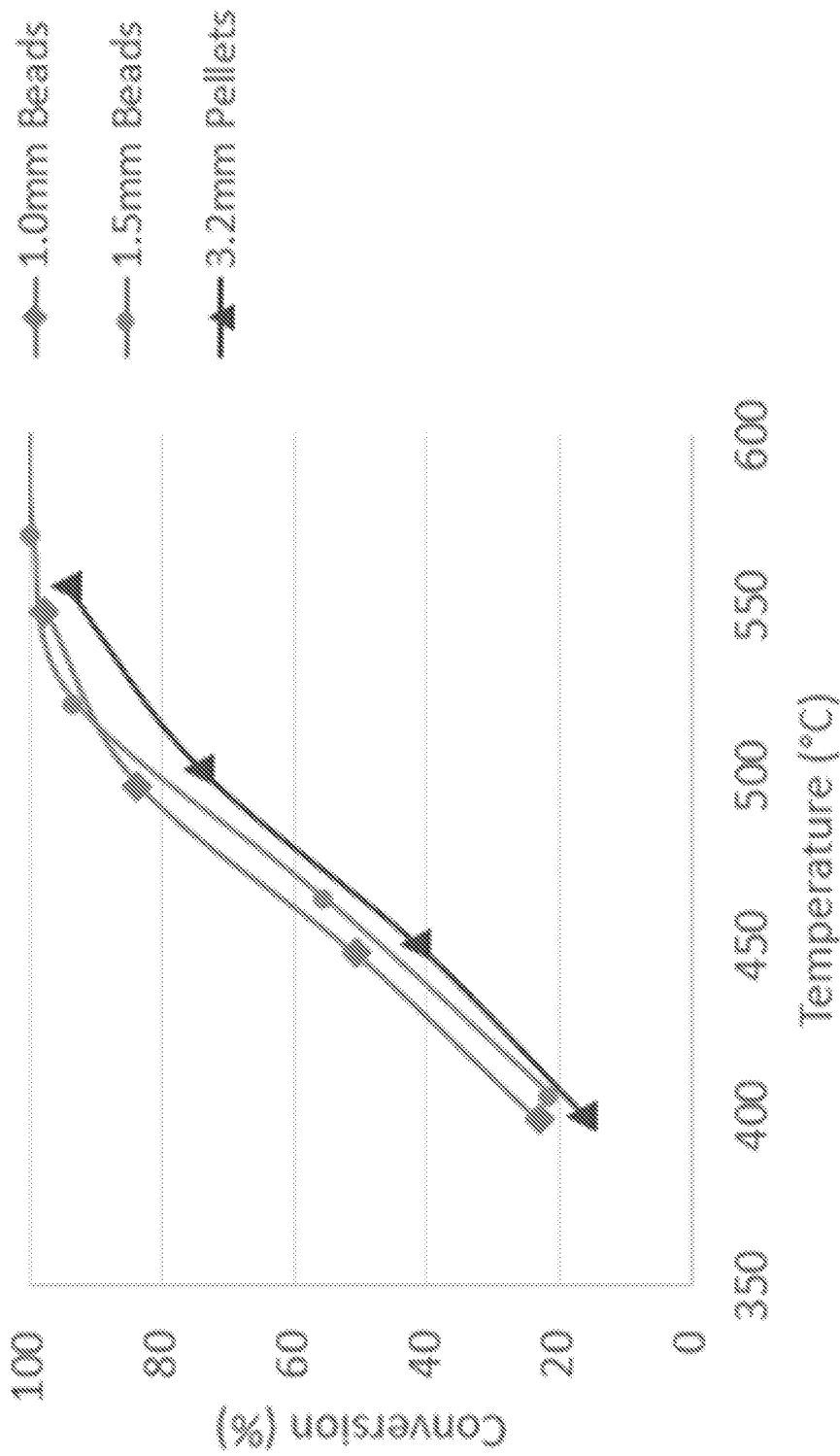


FIG. 12

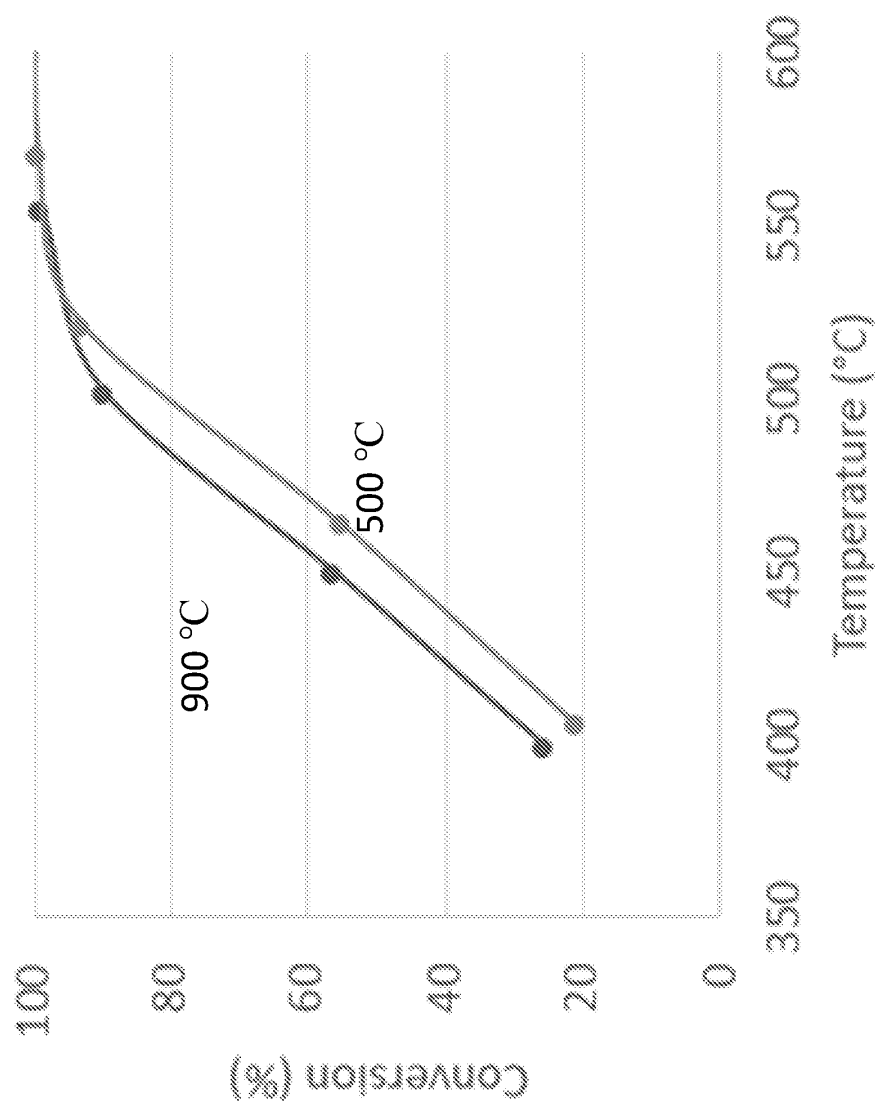


FIG. 13

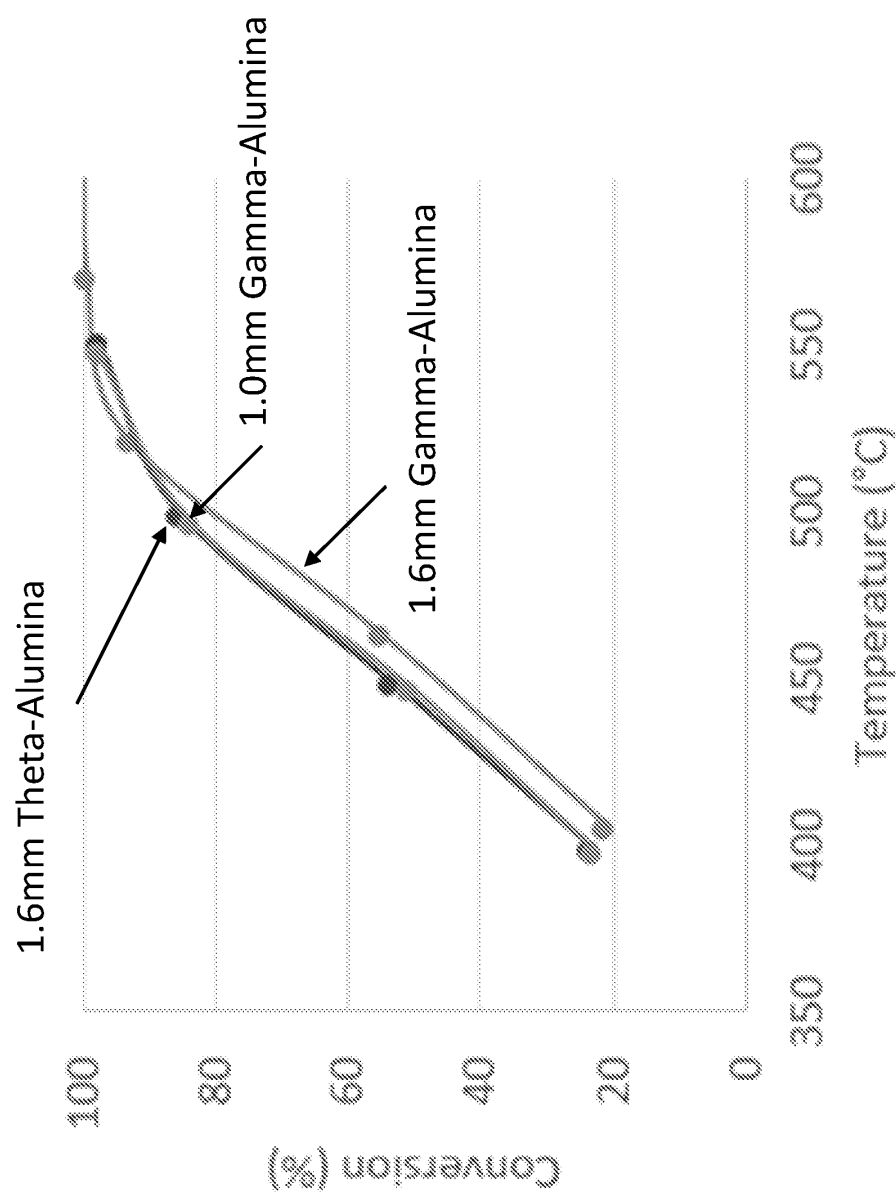


FIG. 14

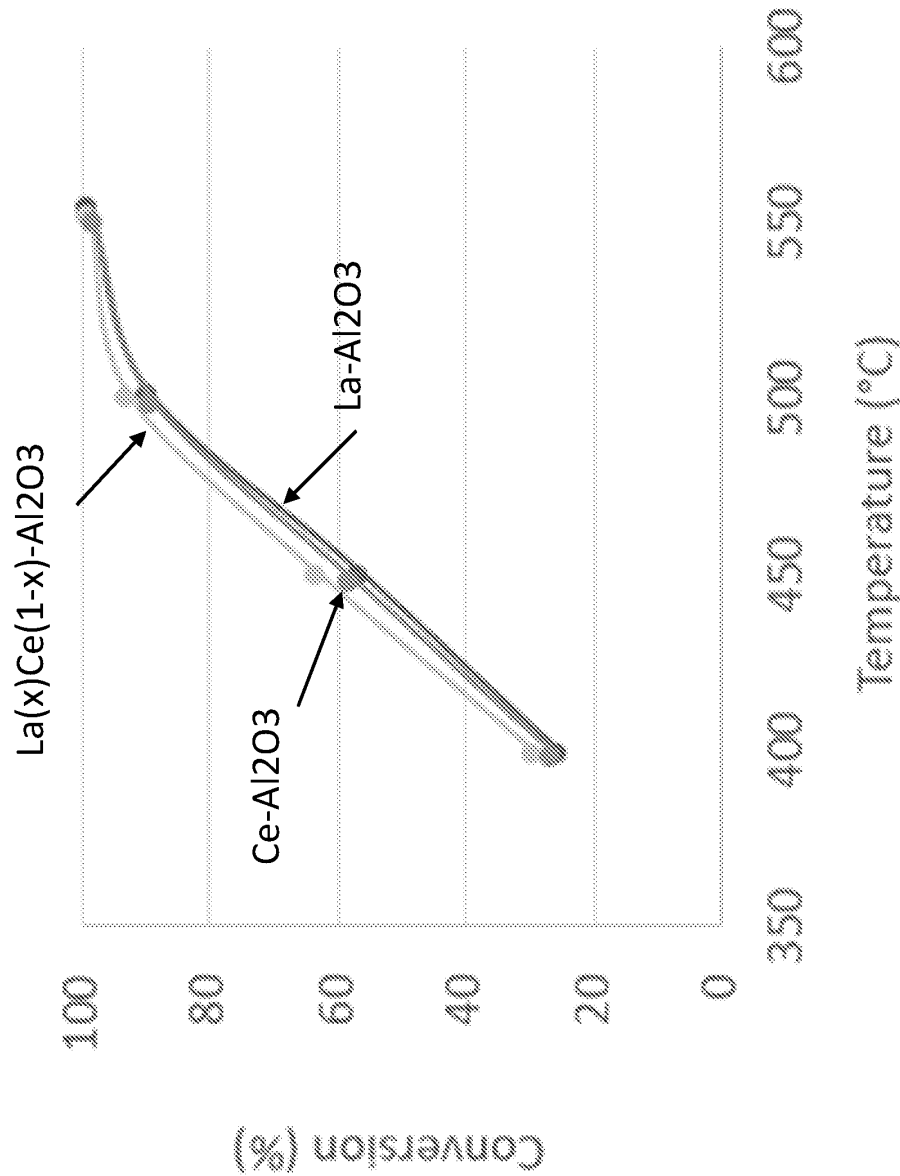


FIG. 15

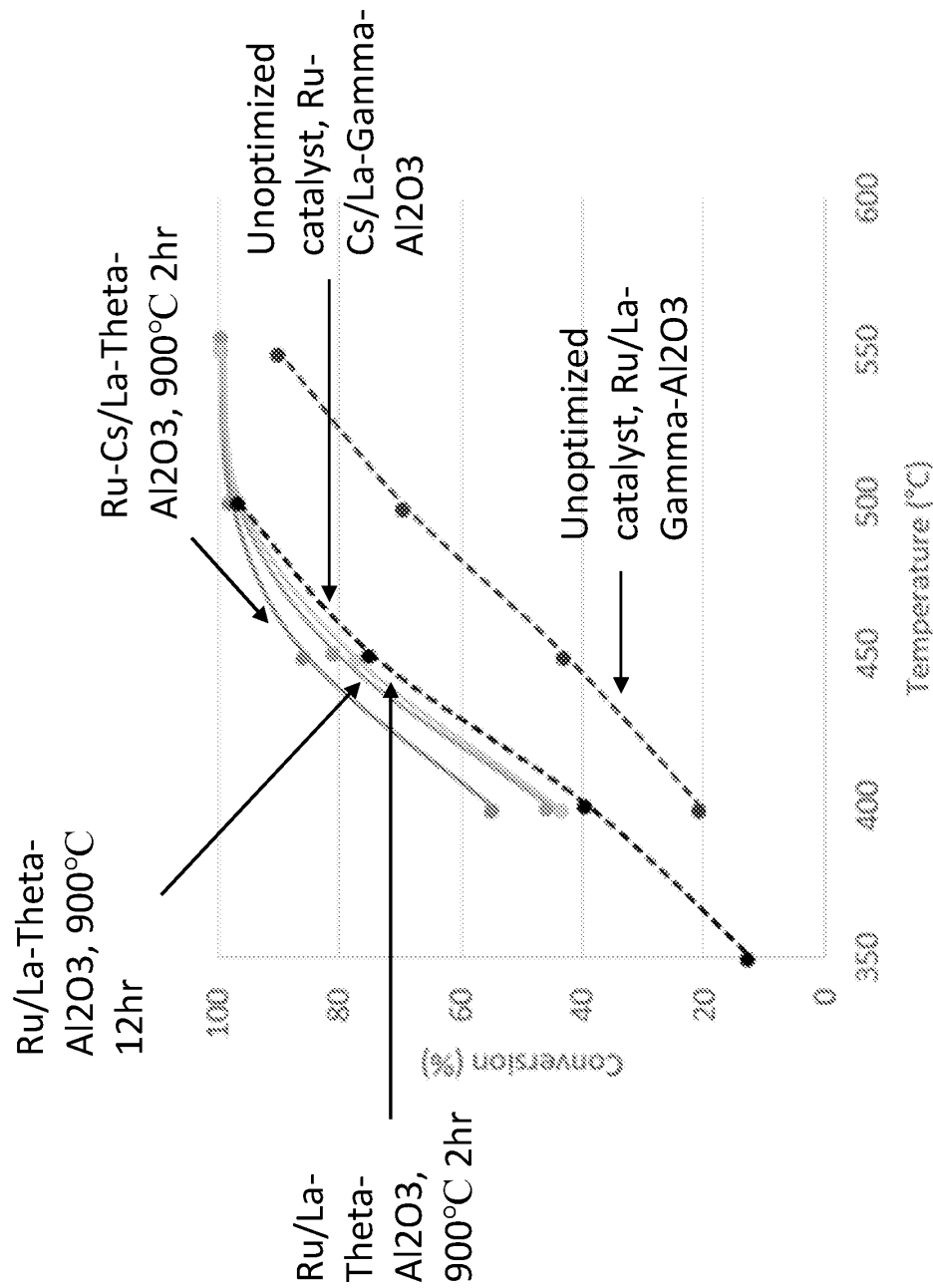


FIG. 16

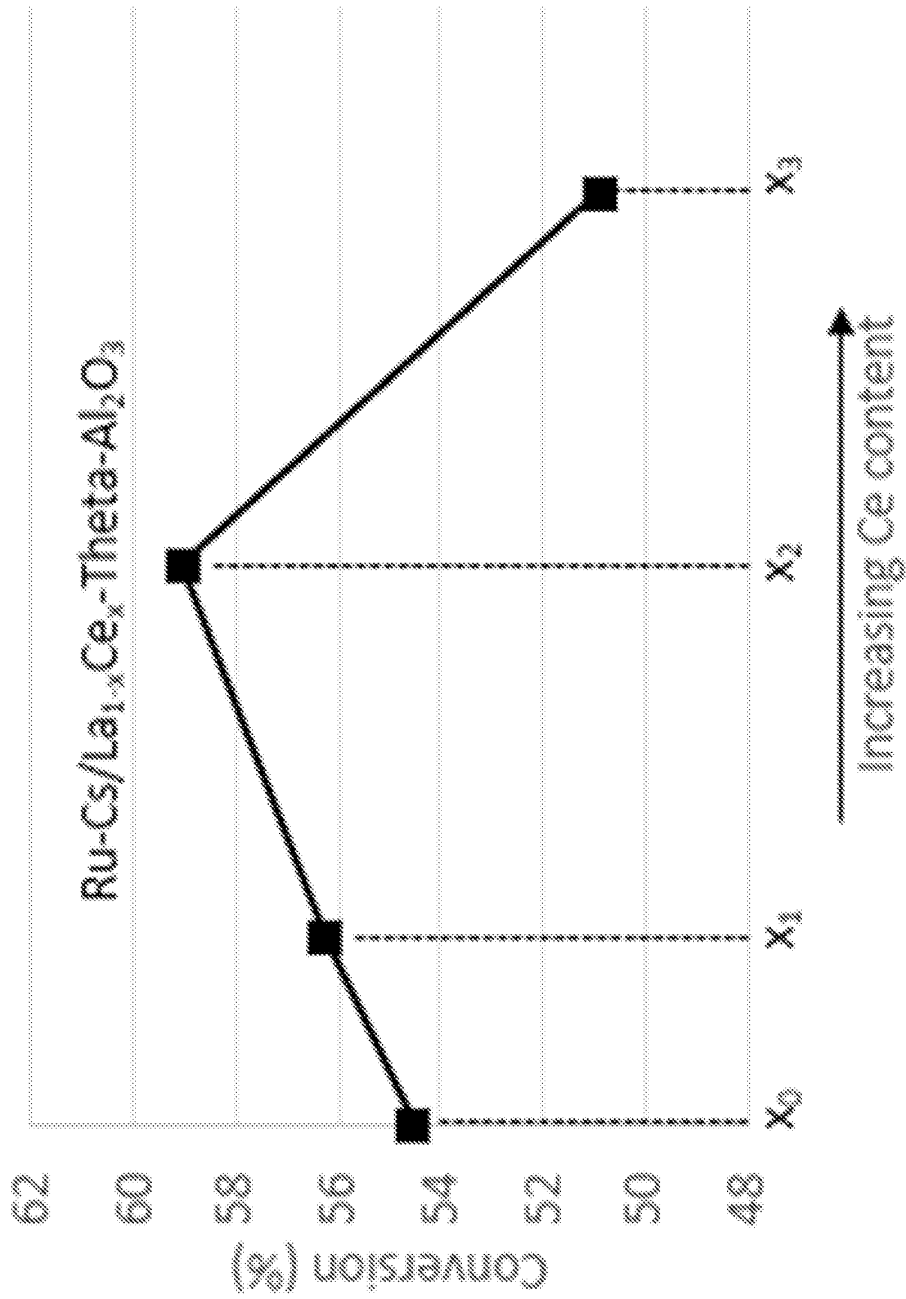


FIG. 17A

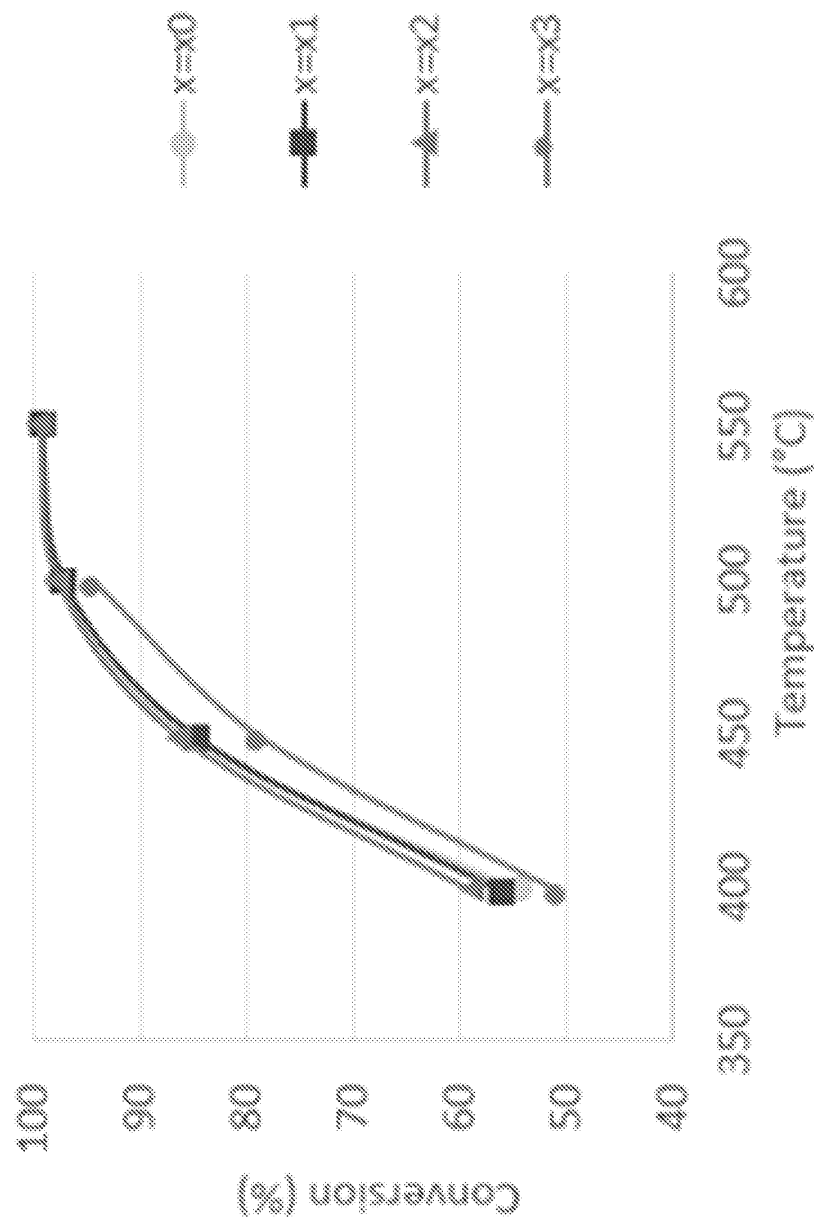


FIG. 17B

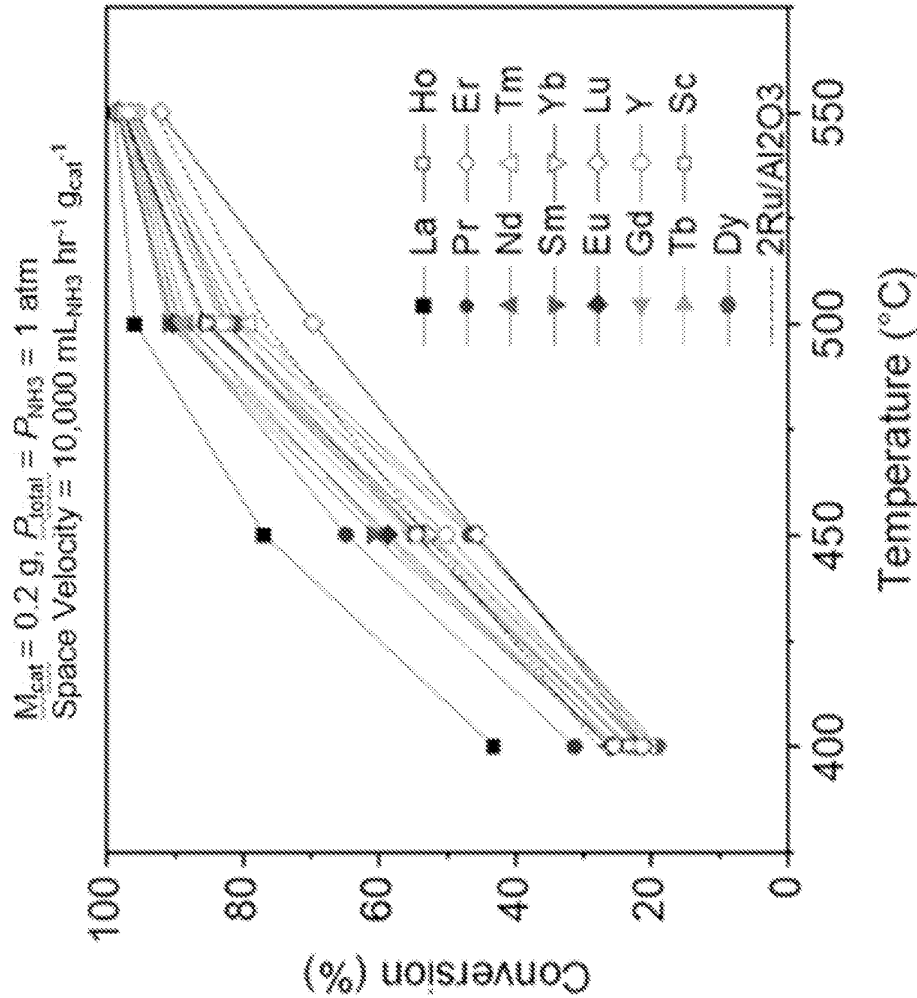


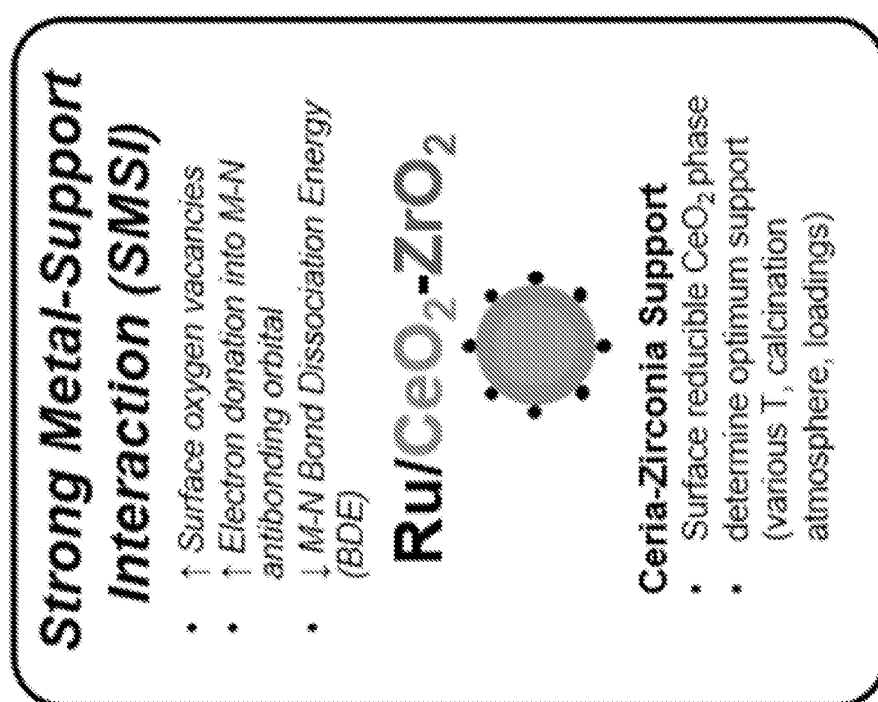
FIG. 18

RE-Al₂O₃ Elemental Composition

Sample	wt% Ru	wt% RE1
2Ru/15La-θ-Al ₂ O ₃	0.8	8.8
2Ru/15Pr-θ-Al ₂ O ₃	1.1	10.4
2Ru/15Nd-θ-Al ₂ O ₃	3.4	21.5
2Ru/15Sm-θ-Al ₂ O ₃	3.0	19.4
2Ru/15Eu-θ-Al ₂ O ₃		
2Ru/15Gd-θ-Al ₂ O ₃	3.3	20.1
2Ru/15Tb-θ-Al ₂ O ₃	2.6	19.7
2Ru/15Dy-θ-Al ₂ O ₃	2.3	16.2
2Ru/15Ho-θ-Al ₂ O ₃	3.1	20.1
2Ru/15Er-θ-Al ₂ O ₃	2.8	21.9
2Ru/15Tm-θ-Al ₂ O ₃	2.5	17.1
2Ru/15Yb-θ-Al ₂ O ₃		
2Ru/15Lu-θ-Al ₂ O ₃	4.0	22.4
2Ru/15Y-θ-Al ₂ O ₃		
2Ru/15Sc-θ-Al ₂ O ₃		

*Elemental Composition determined via XRF

FIG. 19

**FIG. 20**

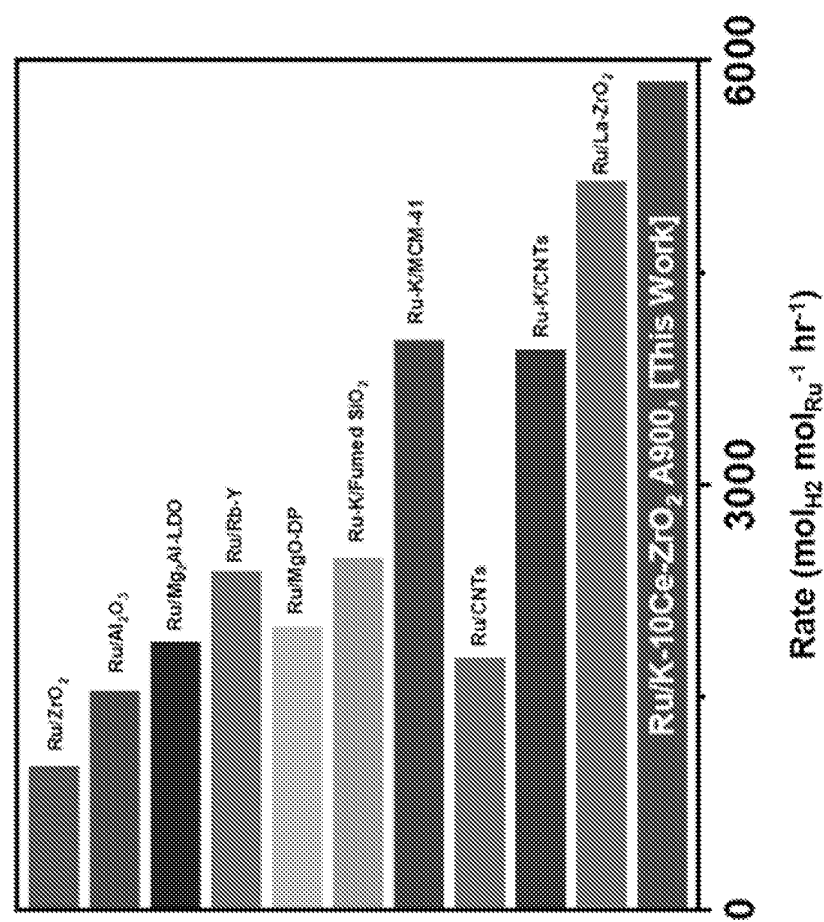


FIG. 21A

Catalyst	Metal Loading (%)	GHSV (mL _{gas} g _{cat} ⁻¹ hr ⁻¹)	Temperature (°C)	Rate (mmol _{H₂} g _{cat} ⁻¹ min ⁻¹)	Rate (mol _{H₂} mol _{cat} ⁻¹ hr ⁻¹)
Ru/K-10Ce-ZrO ₂	1.43	21,283	450	13.8	5,842
Ru/La-ZrO ₂	3	30,000	450	25.4	5,143
Ru-K/CNTs	5	30,000	450	32.6	3,951
Ru/CNTs	5	30,000	450	14.6	1,775
Ru-K/MCM-41	5	36,000	450	20.4	2,473
Ru-K/Fumed SiO ₂	5	36,000	450	16.4	1,990
Ru/MgO-DP	2.1	30,000	450	13.9	4,014
Ru/Rb-Y	1.98	30,000	450	7.7	1,885
Ru/Mg ₂ Al-LDO	4.6	30,000	450	14.3	1,536
Ru/Al ₂ O ₃	4.6	30,000	450	11.7	2,383
Ru/ZrO ₂	5	30,000	450	8.3	1,007

FIG. 21B

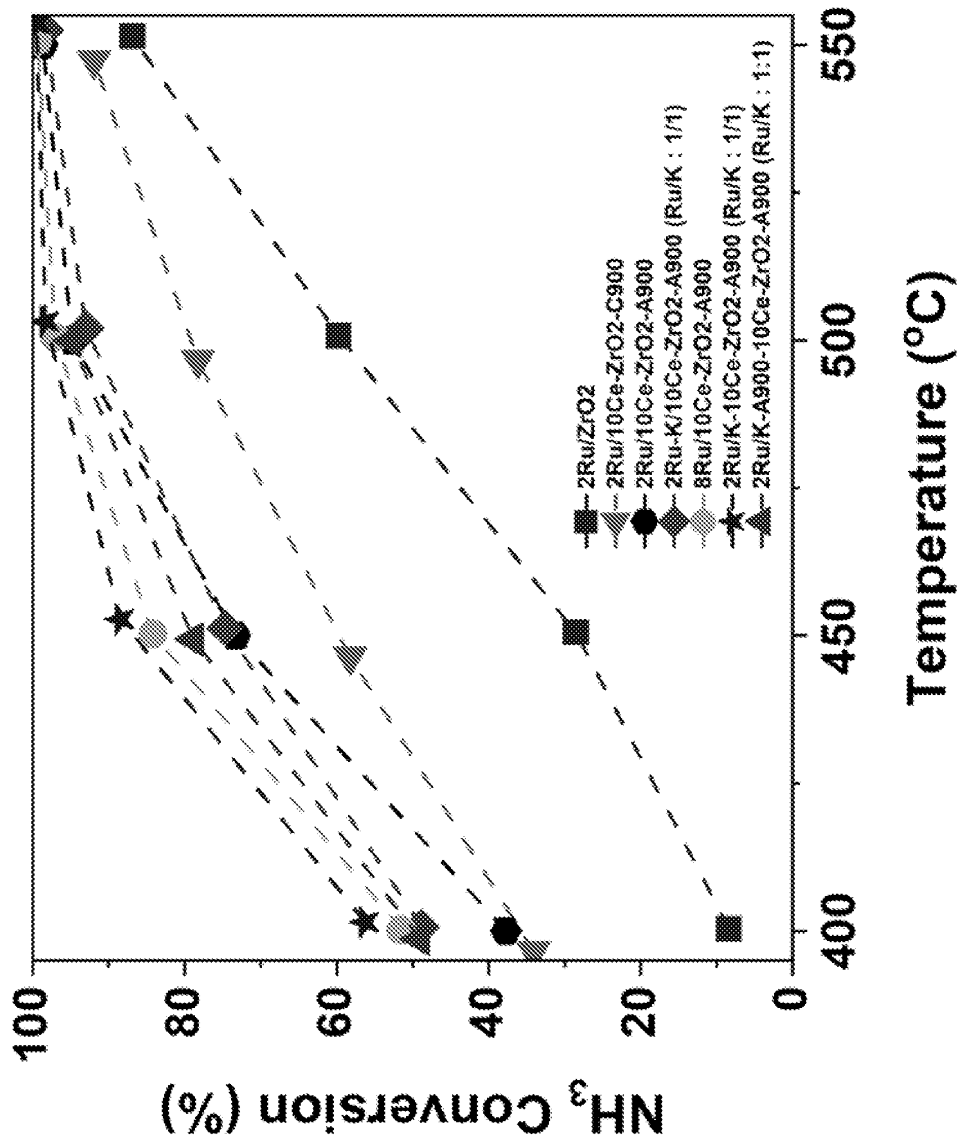


FIG. 22

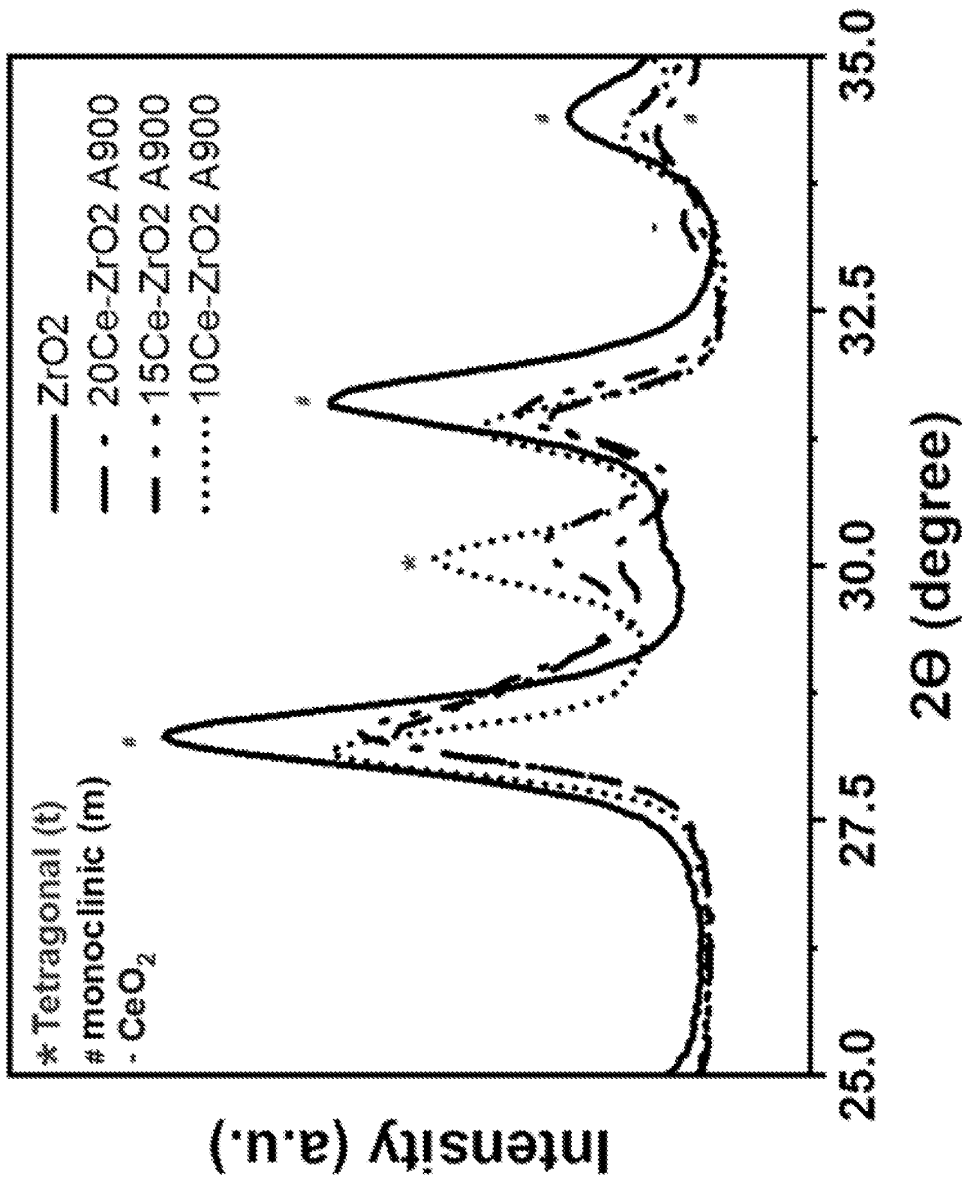


FIG. 23A

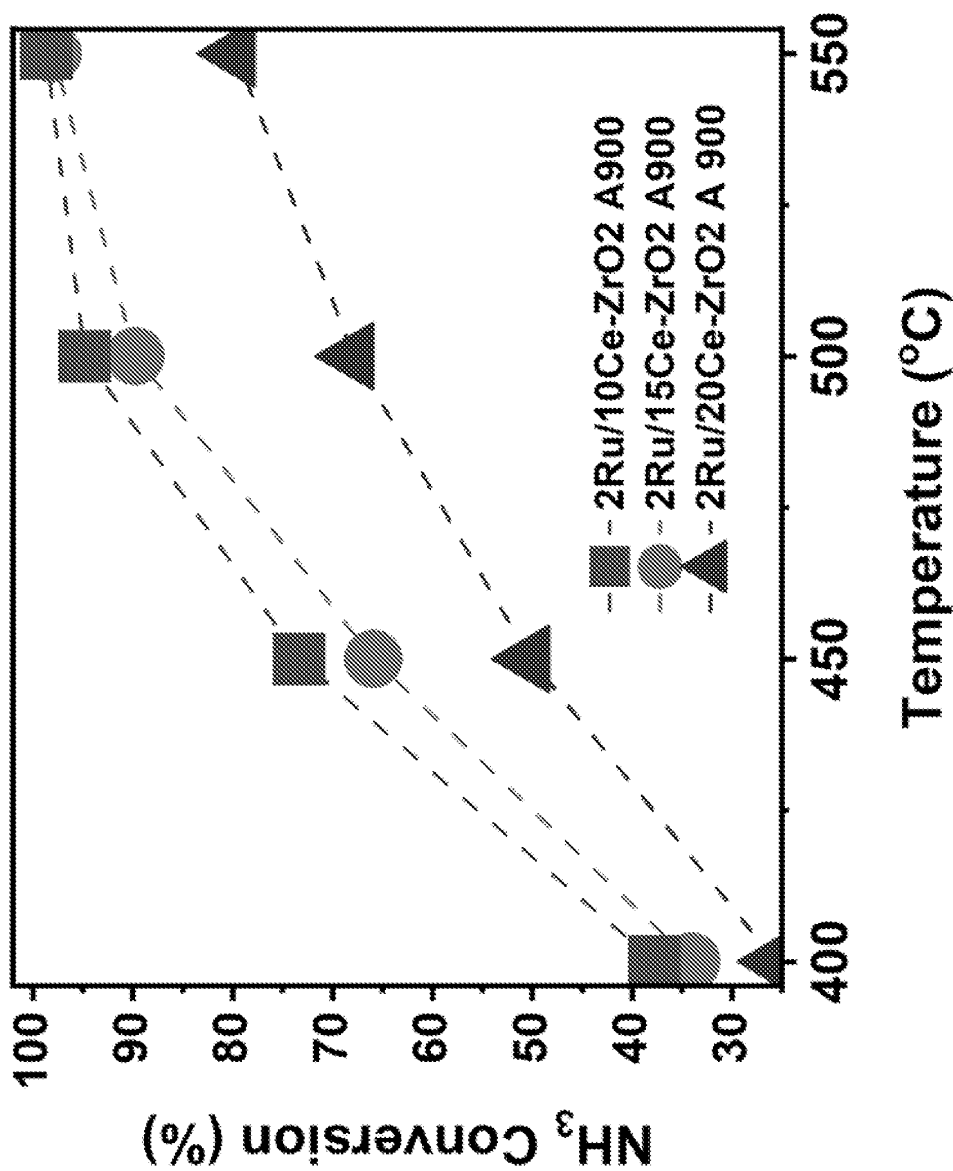


FIG. 23B

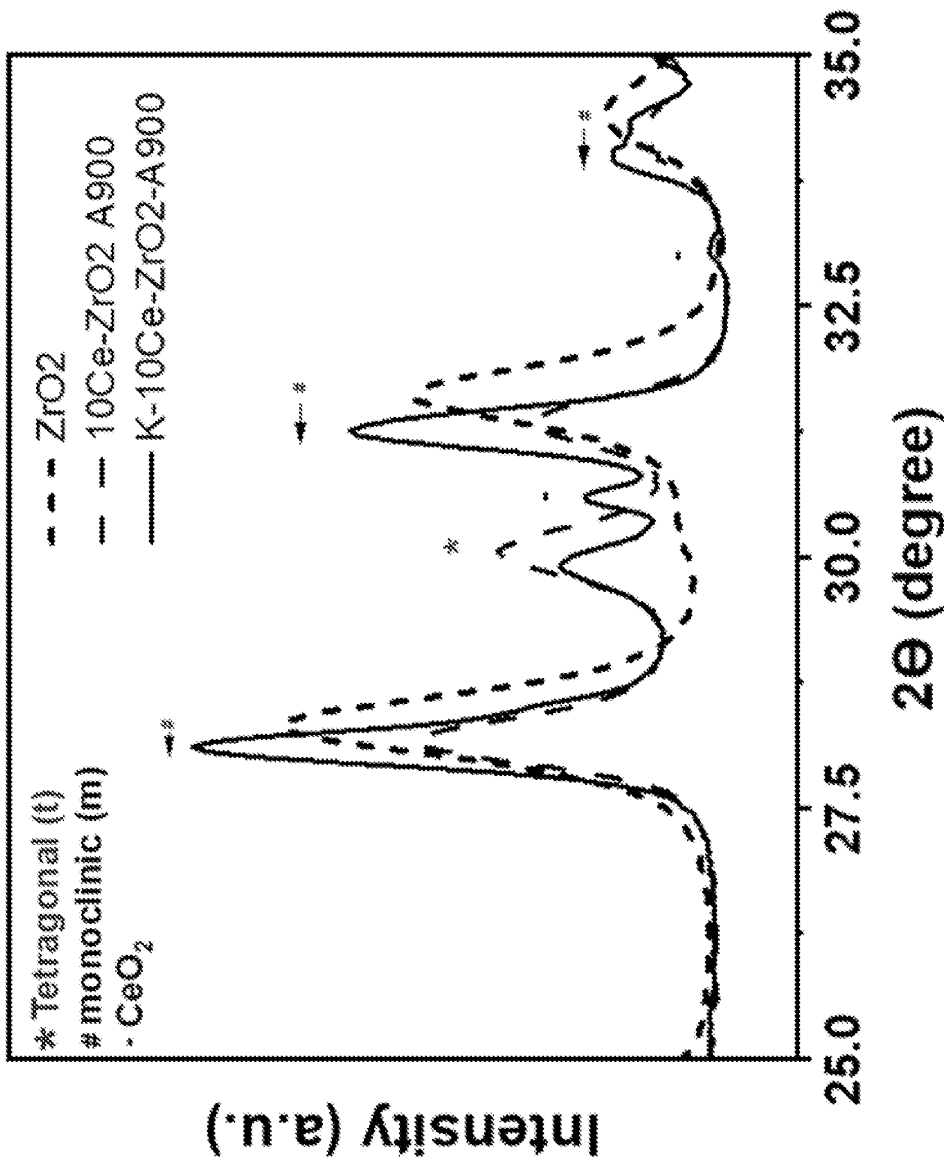


FIG. 24A

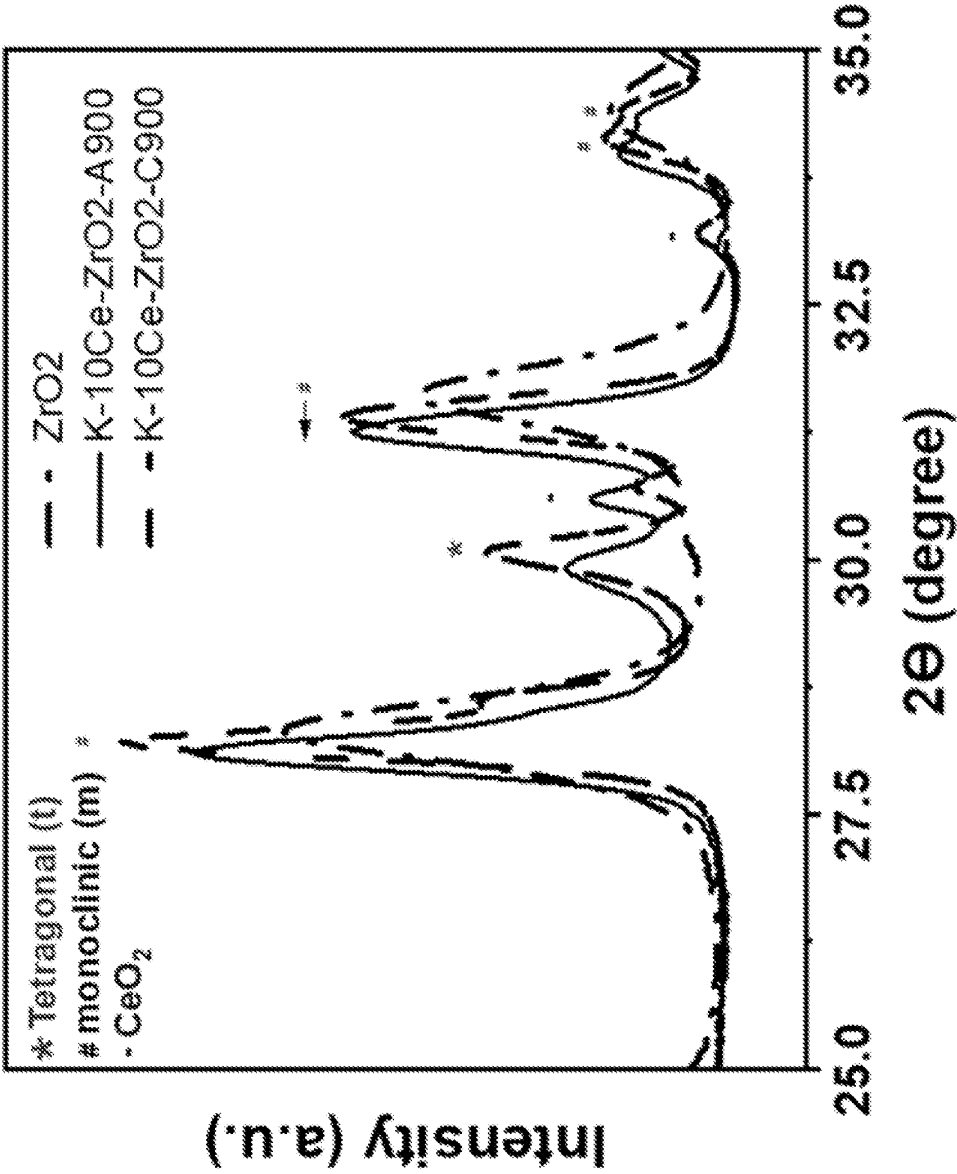


FIG. 24B

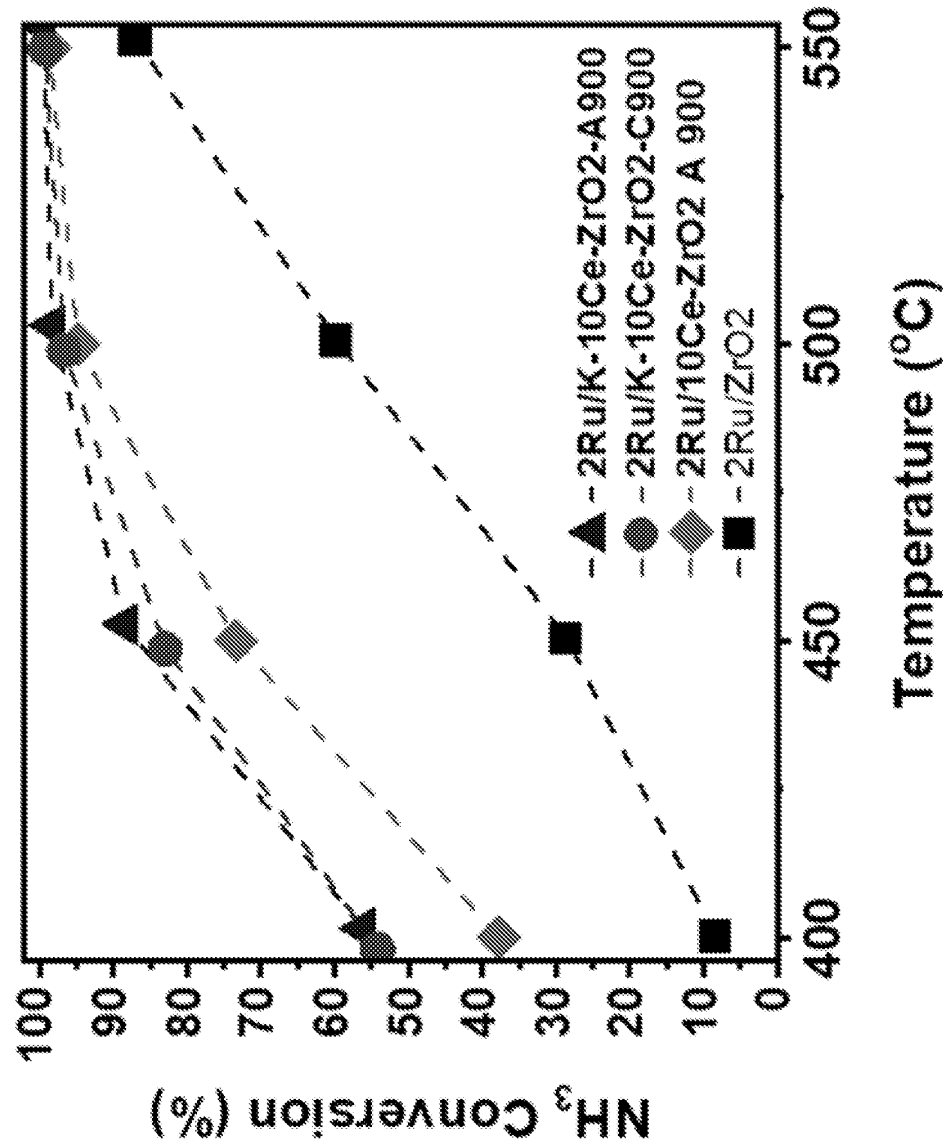


FIG. 24C

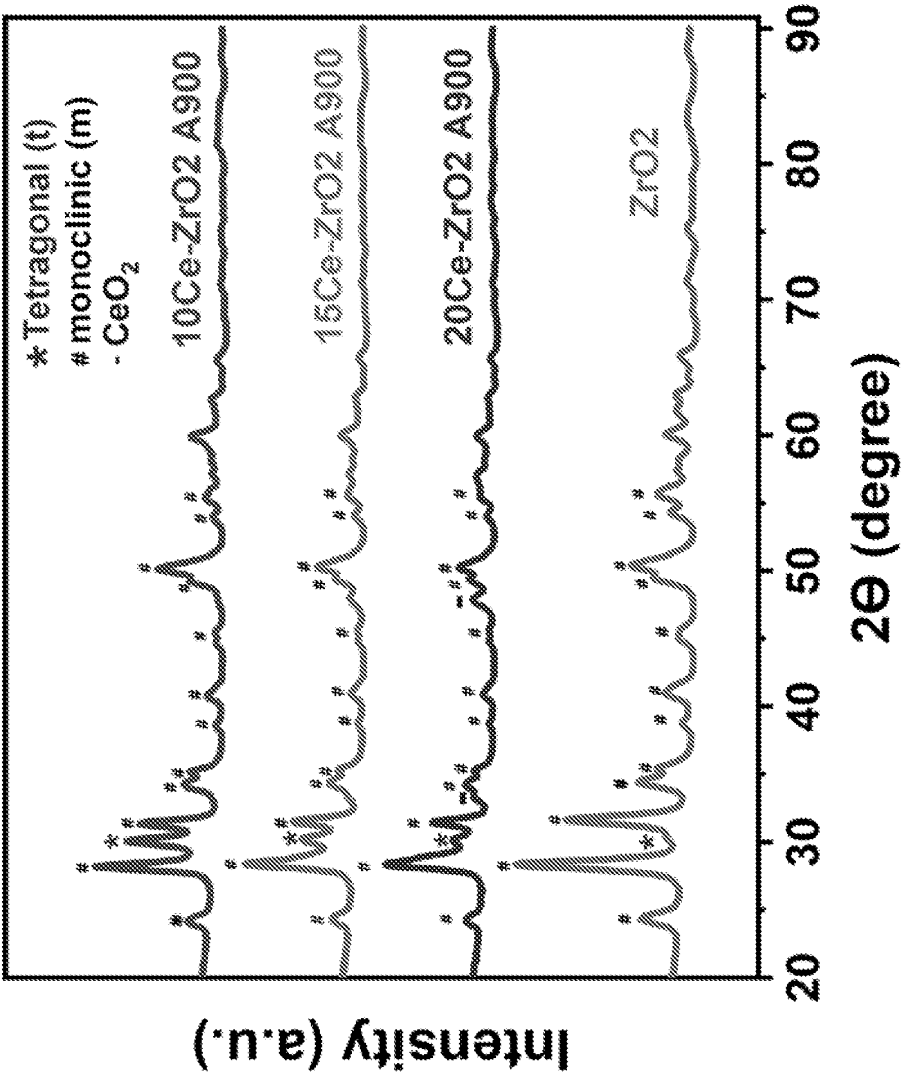


FIG. 25A

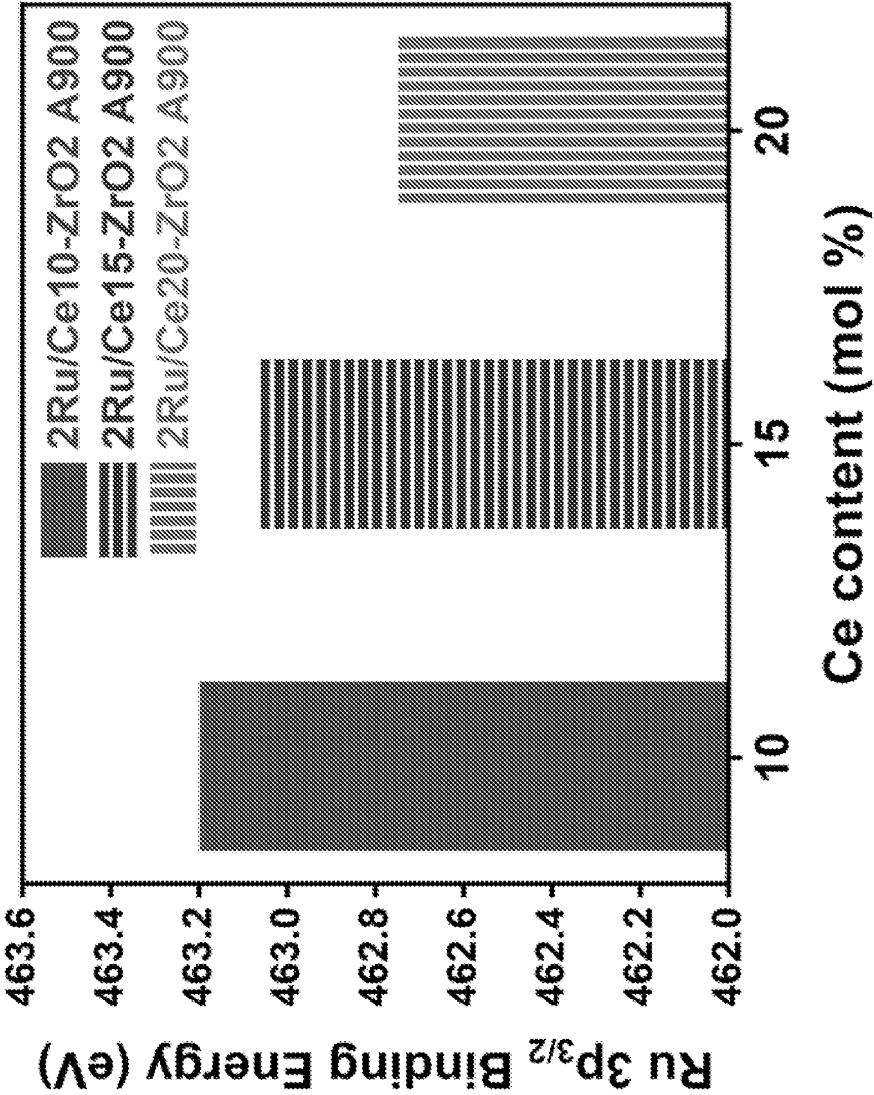


FIG. 25B

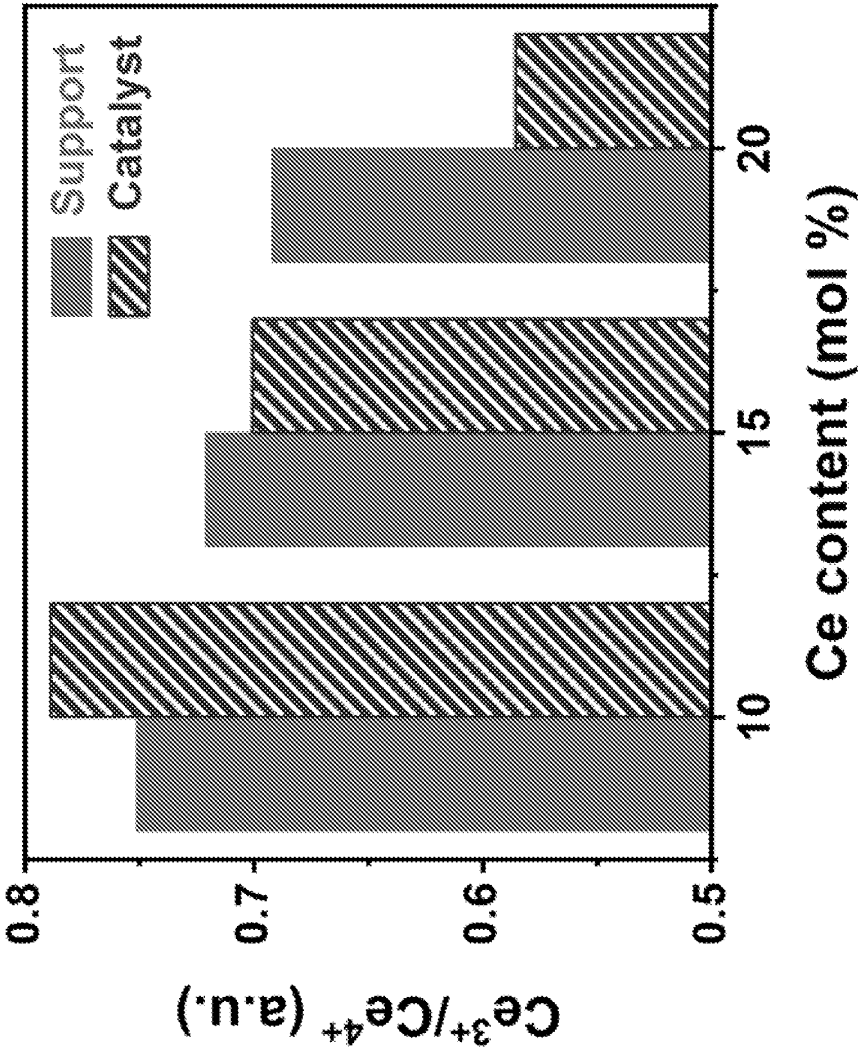


FIG. 25C

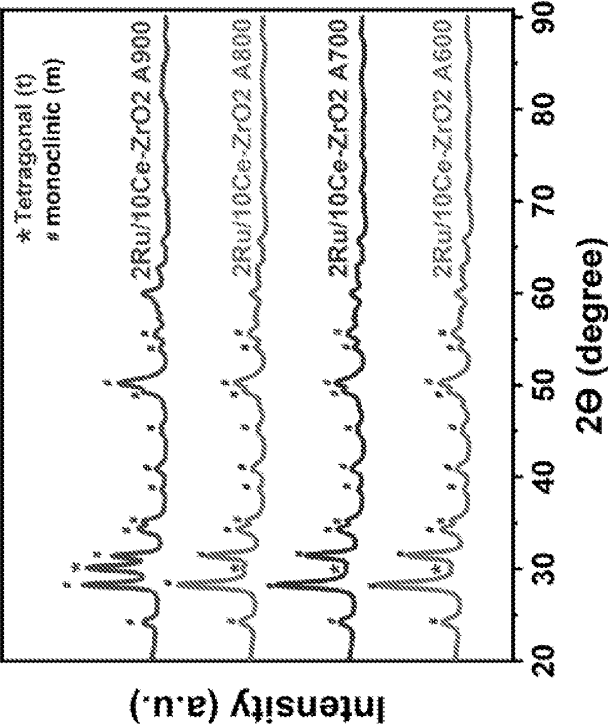


FIG. 26B

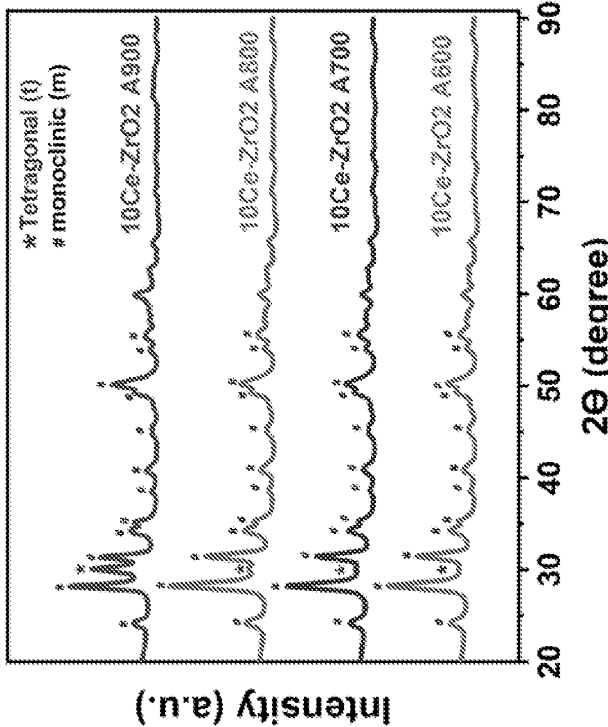


FIG. 26A

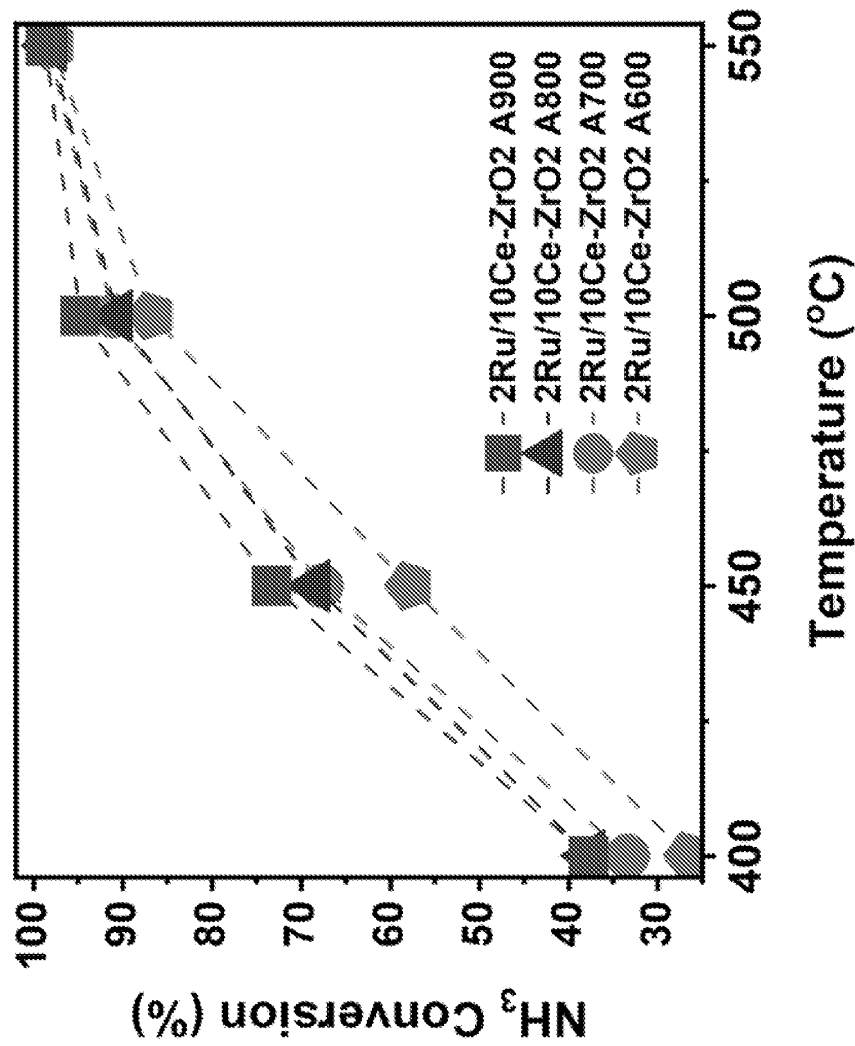


FIG. 26C

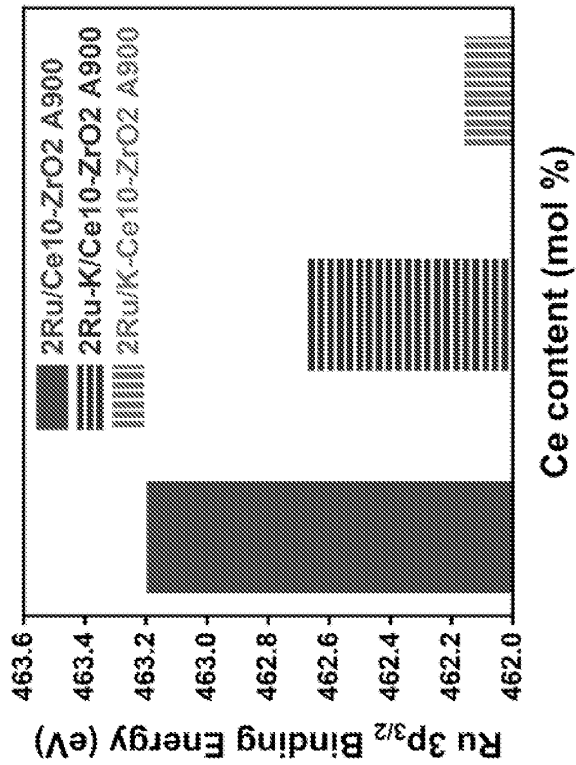


FIG. 27B

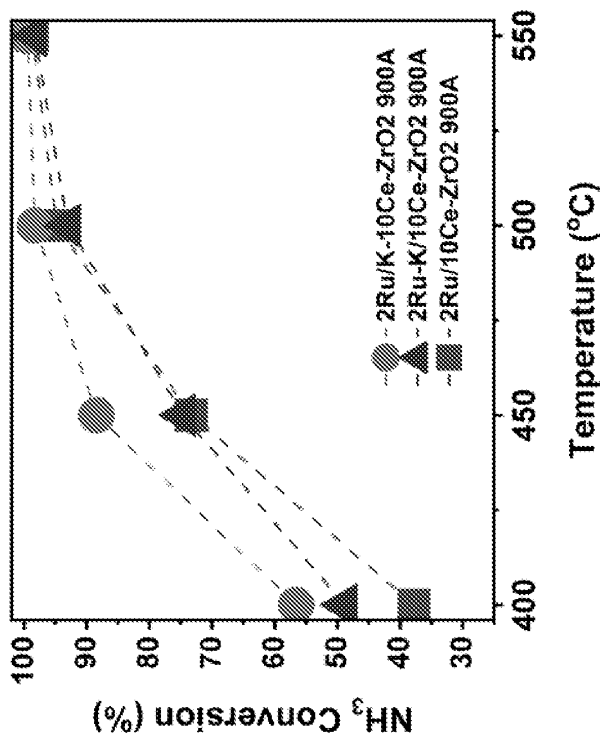


FIG. 27A

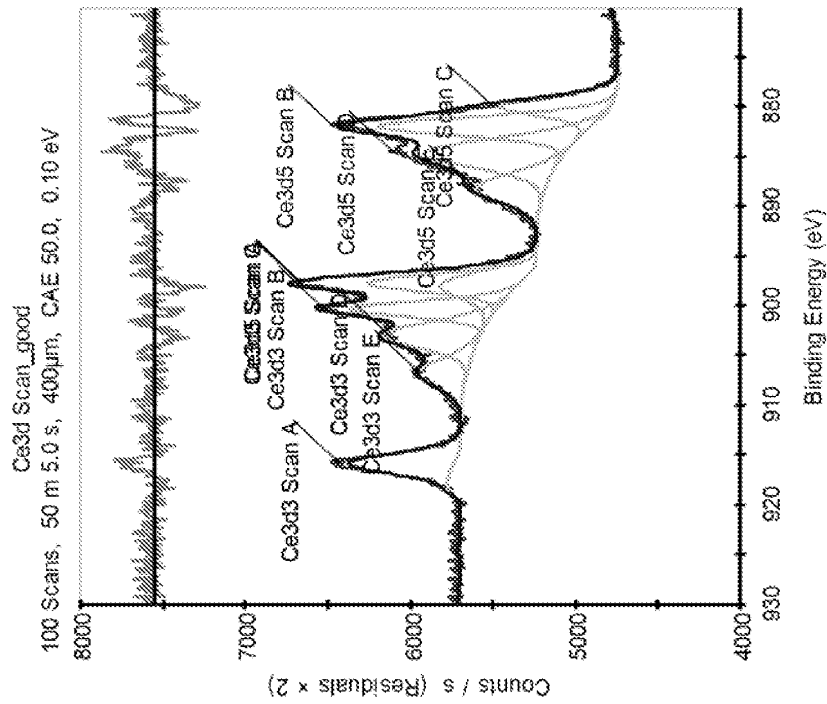


FIG. 28B

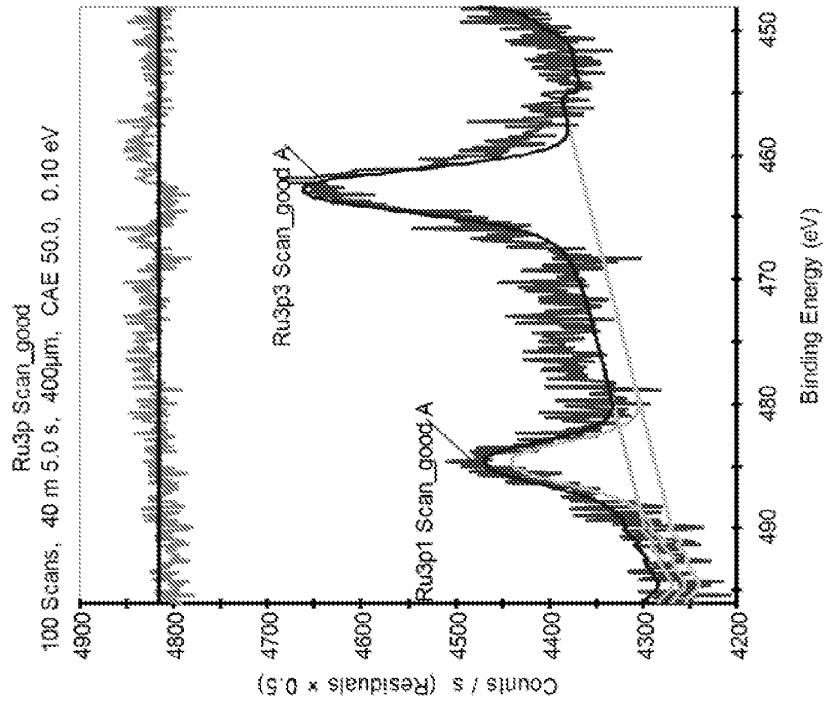


FIG. 28A

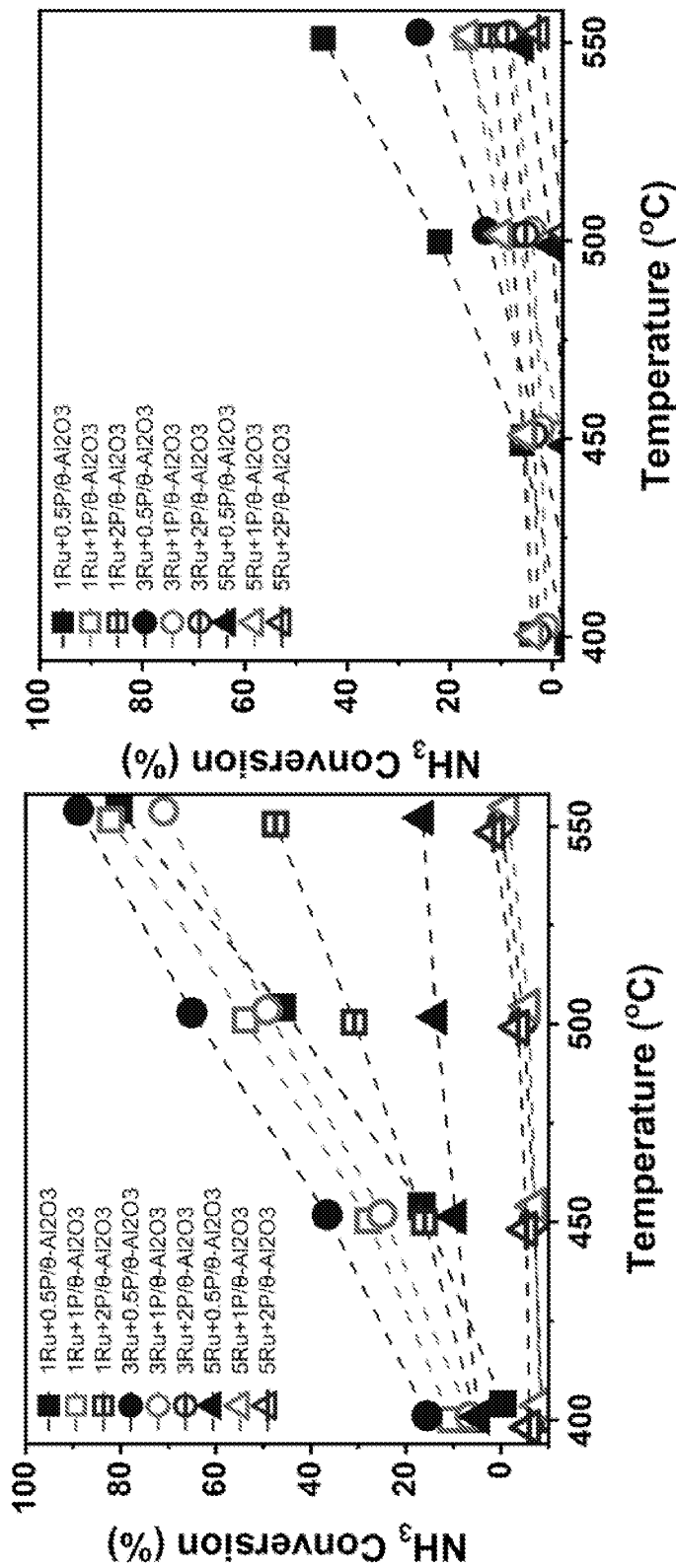


FIG. 29B

FIG. 29A

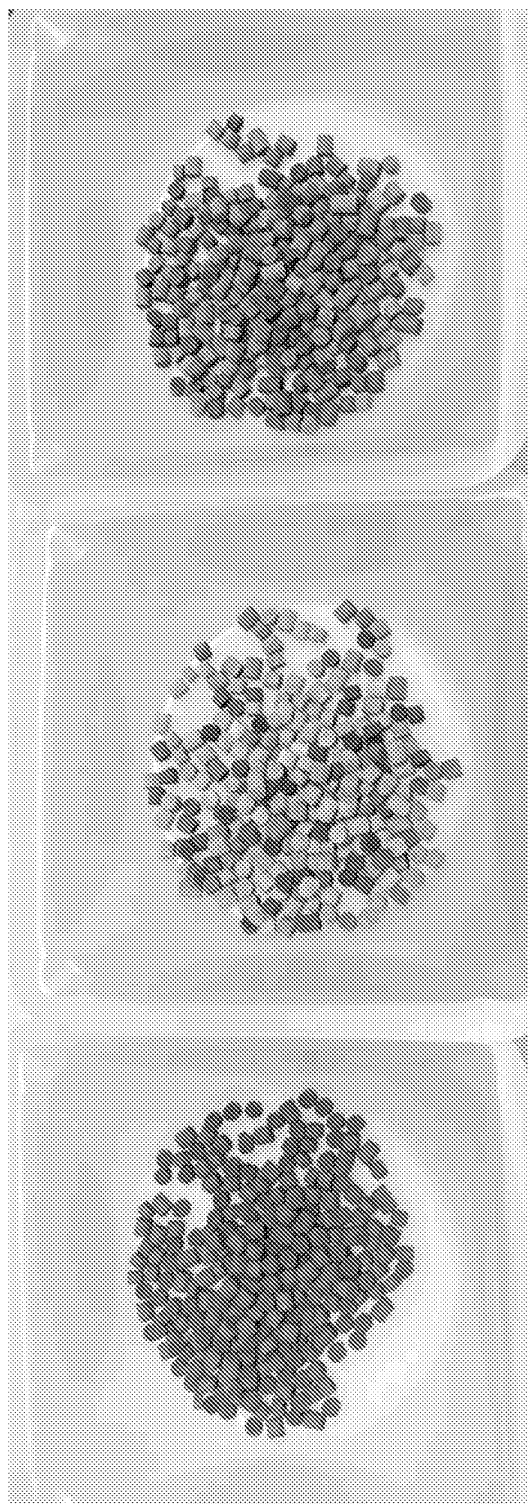


FIG. 30

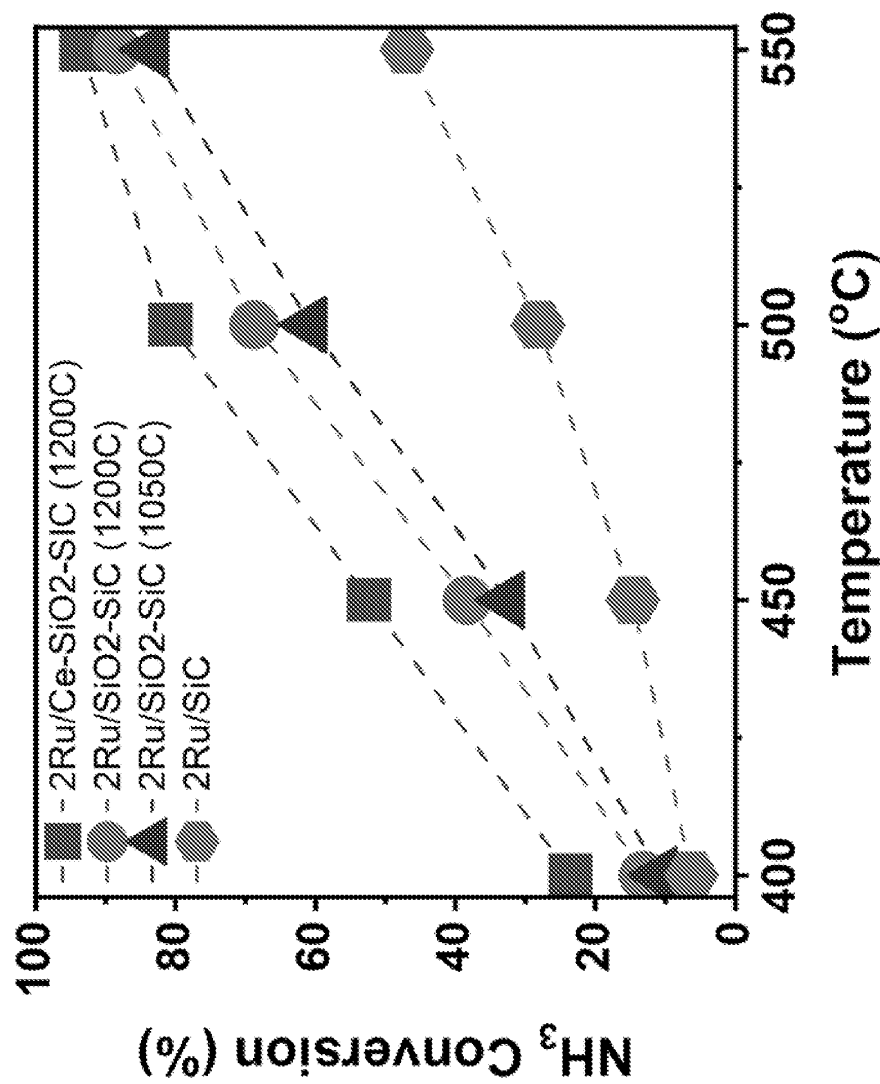


FIG. 31