### Supplemental File

### Hydrogen production through the cooperation of a catalyst synthesized in ethanol medium and the effect of the plasma

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**Figure S1** Comparison of the effect of the plasma and microwave mediums of the Ni-B catalyst synthesized in ethanol medium on the hydrolysis of NaBH4 (30 oC, 2.5% NaBH4, 10 mL solution, 50 mg catalyst, 10% NaOH)



**Figure S2** The effect of different holding times of the Ni-B catalyst synthesized in ethanol medium on the NaBH4 hydrolysis in the plasma medium and the presence of CO2 (30 oC, 2.5% NaBH4, 10 mL solution, 50 mg catalyst, 10% NaOH)



**Figure S3** The effect of different amounts of the Ni-B catalysts synthesized in ethanol medium on NaBH4 hydrolysis in the plasma medium and the presence of CO2 within 10 minutes (30 oC, 2.5% NaBH4, 10 mL solution, 10% NaOH)



**Figure S4** The effect of different amounts of the Ni-B catalyst synthesized in ethanol medium on hydrogen production rate in ethanol medium and presence of CO2 within 10 minutes (30 oC, 2.5% NaBH4, 10 mL solution, 10% NaOH)



**Figure S5** The effect of the Ni-B catalyst synthesized in ethanol medium on NaBH4 hydrolysis in the presence of plasma medium for 10 minutes and CO2 for 10 minutes (30 oC, 10 mL solution, 50 mg catalyst, %10 NaOH)



**Figure S6** Effect of different temperatures of the Ni-B catalysts synthesized in ethanol medium on NaBH4 hydrolysis (10 mL solution, 2.5% NaBH4, 50 mg catalyst, 10% NaOH)



**Figure S7** Effects of different temperatures of the Ni-B catalysts synthesized in ethanol medium on the NaBH4 hydrolysis in the presence of plasma and CO2 (10 mL solution, 2.5% NaBH4, 50 mg catalyst, 10% NaOH)

**Table S1.** Kinetic parameters and hydrogen production rates of hydrolysis reaction at different temperatures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Temperature (oC)** | **Reaction speed degree (n)** | **The reaction speed constant (k)** | **Hydrogen production rate (mL/gcat dk)** | **R2** |
| 30 | 0.33 | 0.001061 | 1041 | 0.998066 |
| 40 | 0.33 | 0.001719 | 2125 | 0.993744 |
| 50 | 0.33 | 0.003782 | 4390 | 0.998763 |
| 60 | 0.33 | 0.005236 | 7134 | 0.988073 |



**Figure S8** The reaction kinetics of the Ni-B catalysts synthesized in the plasma and ethanol medium at different temperatures in the presence of CO2 (10 mL solution, 2.5% NaBH4, 50 mg catalyst, 10% NaOH)

**Table S2** Comparison of the catalytic performance of various catalysts for the hydrolysis of NaBH4

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Catalysts** | **Method** | **Temp.****(oC)** | **Ea****(kJ/mol)** | **Max. hydrogen** **production rate (mL/gcat dk)** | **Ref.** |
| Co/Al2O3 | Chemical reduction | 30 | 32.63 | 220 | (Ye et al. 2007) |
| Co2B | Chemical reduction | 20 | - | 468.3 | (Liu BH et al. 2006) |
| Ni2B | Chemical reduction | 20 | - | 18.3 | (Liu BH et al. 2006) |
| Ni-Ru/50WX8 | Electroless deposition | - | 52.7 | 400 | (Liu CH et al. 2009) |
| Co-Ni-Mo-P/γ-Al2O3 | Electroless deposition | 90 | 52.4 | 10125 |  (Wang LN et al. 2016) |
| Ni-Co-B | Chemical reduction | 575 | 62 | 2608 | (Ingersoll et al. 2007) |
| Co-Ni-P/Cu sheet | Electroless plating | 78 | 53.5 |  2172.4 | (Wang Y et al. 2017) |
| ***Ni-B*** | ***Chemical reduction*** |  ***60*** | ***46.83*** | ***7134*** | ***This work*** |



**Figure S9** Arrhenius equation according to the “n” degree of the Ni-B catalyst synthesized in ethanol medium