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Electrolessly Deposited Transition Metal Phosphide Catalysts for Hydrogen Generation from Hydrolysis of Alkaline Sodium Borohydride

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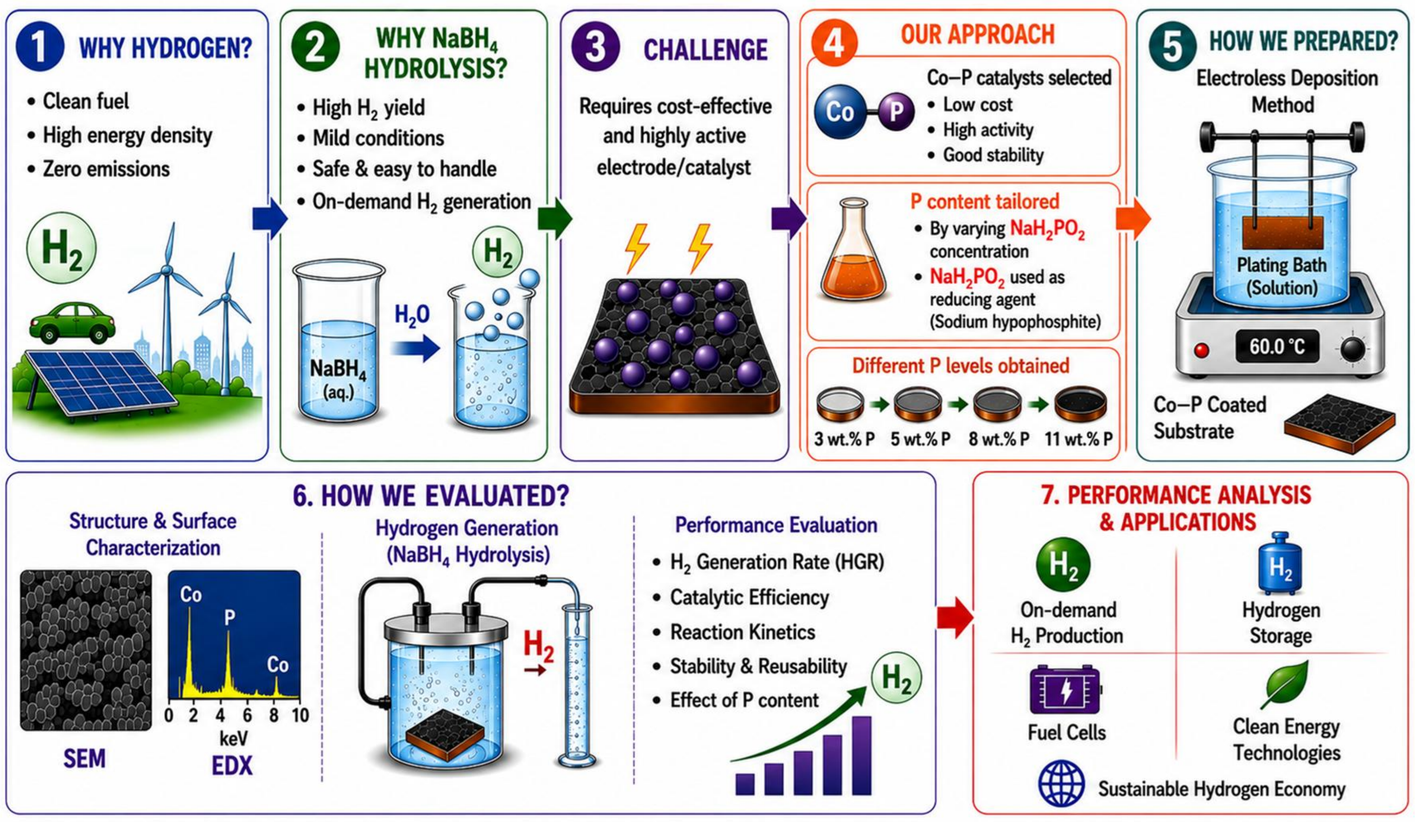
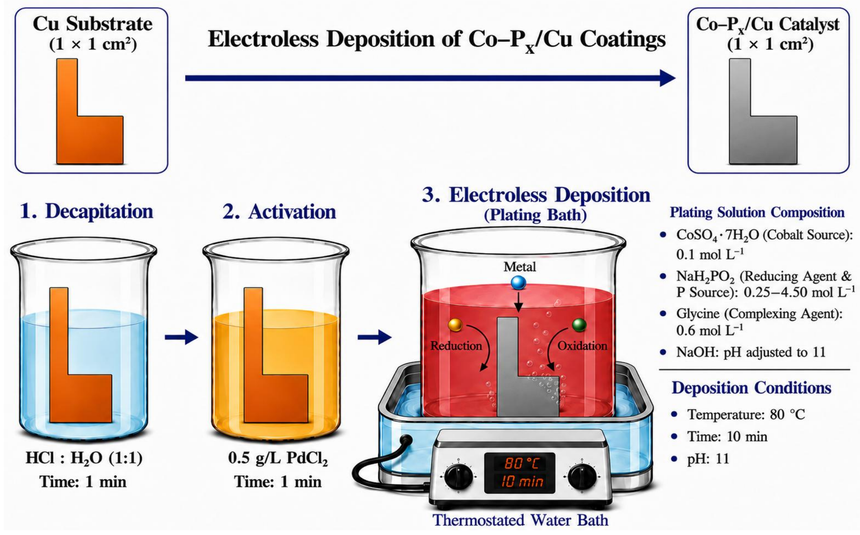
INTRODUCTION & AIM



FABRICATION of CATALYSTS



SEM & EDS ANALYSIS

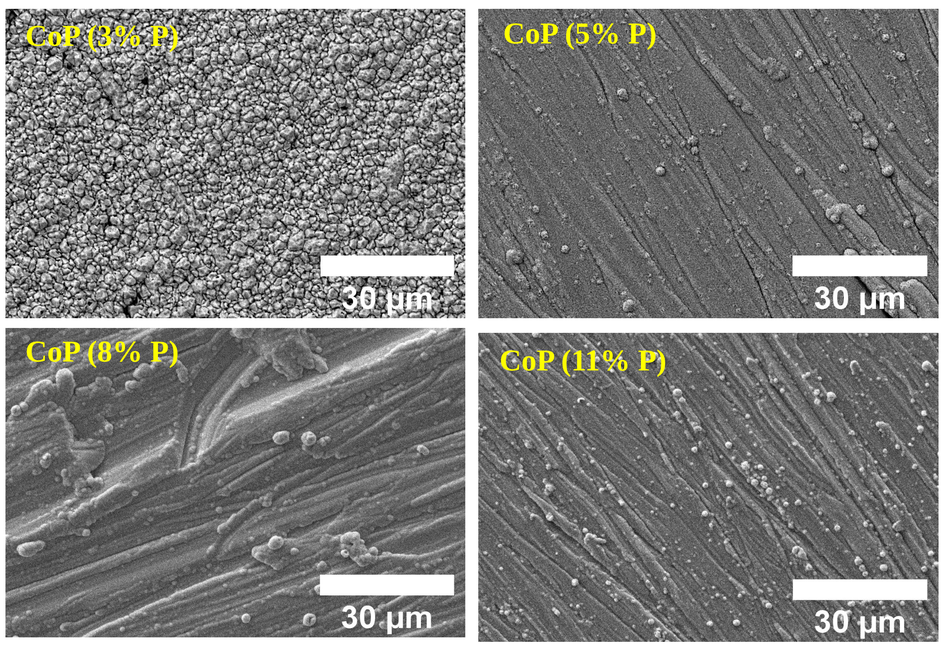


Fig. 1. SEM images of the Co-P_x coatings with different P contents (3, 5, 8 and 11 wt%) on copper substrate.

Table 1. Composition of Co-P_x coatings deposited on the copper sheet.

Catalyst	Element, wt%	
	Co	P
Co-P/Cu (3%P)	97.12	2.88
Co-P/Cu (5%P)	95.13	4.87
Co-P/Cu (8%P)	92.02	7.98
Co-P/Cu (11%P)	88.87	11.13

RESULTS & DISCUSSION

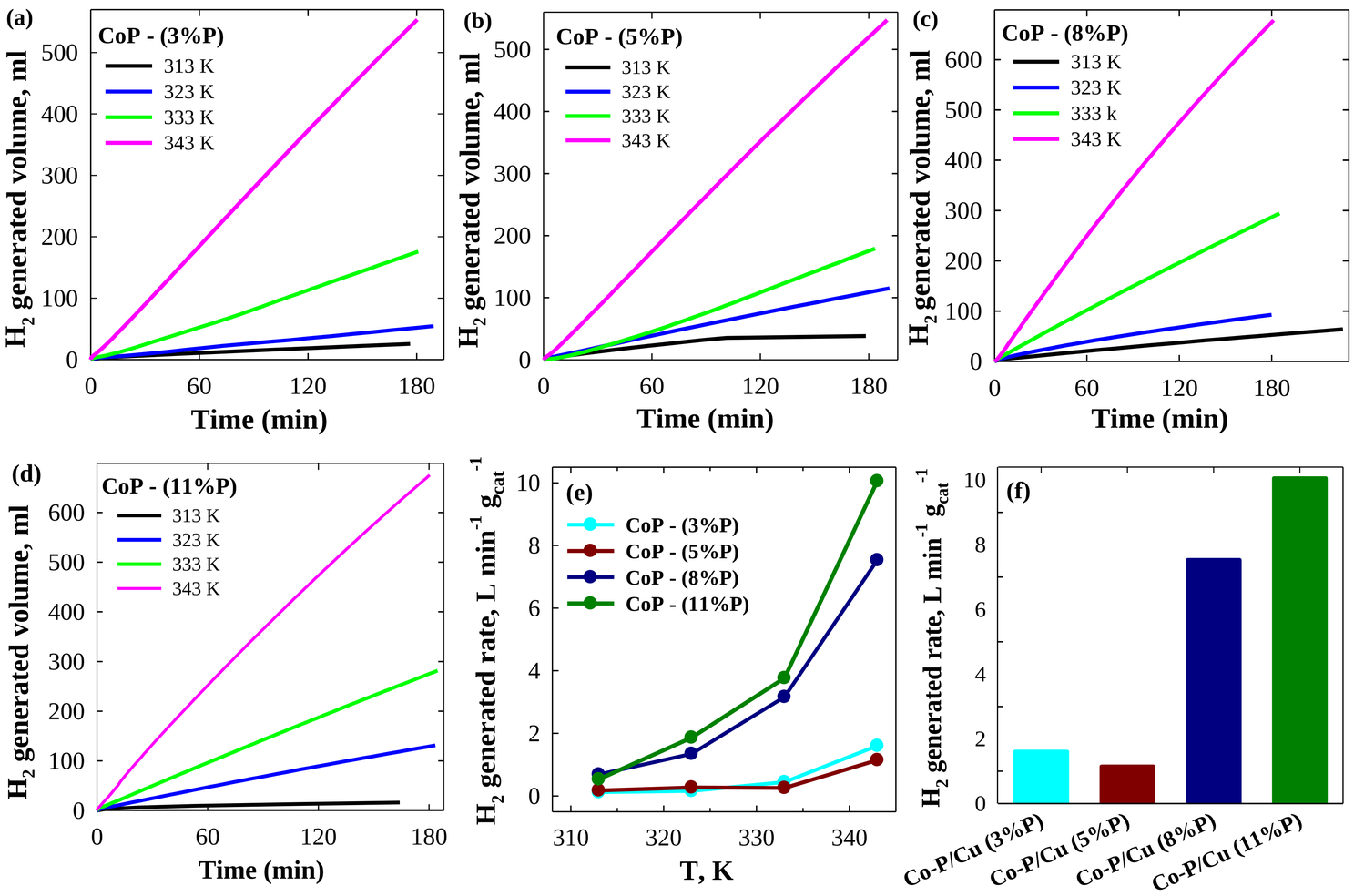


Fig. 2. (a-d) Hydrogen generation from sodium borohydride hydrolysis reaction at different temperatures, catalysed by Co-P_x coatings deposited on Cu sheet. **(e)** Hydrogen generation rate on Co-P_x coatings at 313-343 K. **(f)** Bar graphs of hydrogen generation rate on Co-P_x coatings at 343 K.

Table 2. Hydrogen generation rates and activation energies by the Co-P_x coatings at different temperatures (313-343K).

Catalyst	E_a, kJ mol^{-1}	T, K	Hydrogen Generation Rate, L min^{-1} g$_{cat}^{-1}$
Co-P/Cu (3%P)	77.56	313	0.12
		323	0.16
		333	0.44
		343	1.60
Co-P/Cu (5%P)	49.08	313	0.18
		323	0.27
		333	0.26
		343	1.15
Co-P/Cu (8%P)	71.64	313	0.69
		323	1.34
		333	3.16
		343	7.53
Co-P/Cu (11%P)	85.04	313	0.53
		323	1.86
		333	3.77
		343	10.05

CONCLUSIONS

❖ Co-P_x catalysts containing different amounts of phosphorus (x = 3, 5, 8, and 11 wt.%) were successfully synthesized and evaluated for hydrogen generation from 5 wt.% $NaBH_4$ + 0.4 wt% NaOH solution over the temperature range of 313–343 K.

❖ The catalytic activity increased progressively with increasing phosphorus concentration, indicating the significant role of phosphorus in enhancing the performance of Co-based catalysts.

❖ Hydrogen generation rates increased with increasing reaction temperature, reaching values in the range of **1.15-10 L min^{-1}g^{-1}at 343 K.**

❖ The calculated activation energies **(49-85 kJ mol^{-1})** indicate favourable reaction kinetics for the $NaBH_4$ hydrolysis process.

❖ Among the investigated catalysts, **Co-P (11 wt.% P)** exhibited the highest catalytic activity, achieving a maximum hydrogen generation rate of **10.05 L min^{-1}g^{-1}at 343 K**.

❖ The combination of high catalytic activity, low material cost, and facile synthesis highlights the potential of Co-P_x catalysts as efficient alternatives for sustainable hydrogen production from $NaBH_4$ hydrolysis.

ACKNOWLEDGMENT

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