Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Insight to thedevelopment and proceeding of Au@Al-$CeVO_4$ catalysts for water splitting: an advance outlook for hydrogen generation on sunlight

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Factors affecting the activity of photocatalysts

Temperature

Photoreaction for water splitting is not thermodynamically favorable but it can increase or decrease the activity of photocatalyst for H_2. Photoreaction initiates with light absorption, in the absence of light no hydrogen produced. At low temperature H_2 evolution rate was low because transfer of electrons towards conduction band is less at high temperature it increases and enhance the production of hydrogen. Temperature has no significant effect on activity of photocatalyst but affects the absorption and desorption process of the hydrogen gas on catalyst surface. As the temperature increased desorption of H_2 gas from the catalyst increased and more hydrogen produced. For the best performance of photocatalyst optimized temperature was 60 ºC[1]. At this temperature hydrogen evolution was maximum see Figure S1.

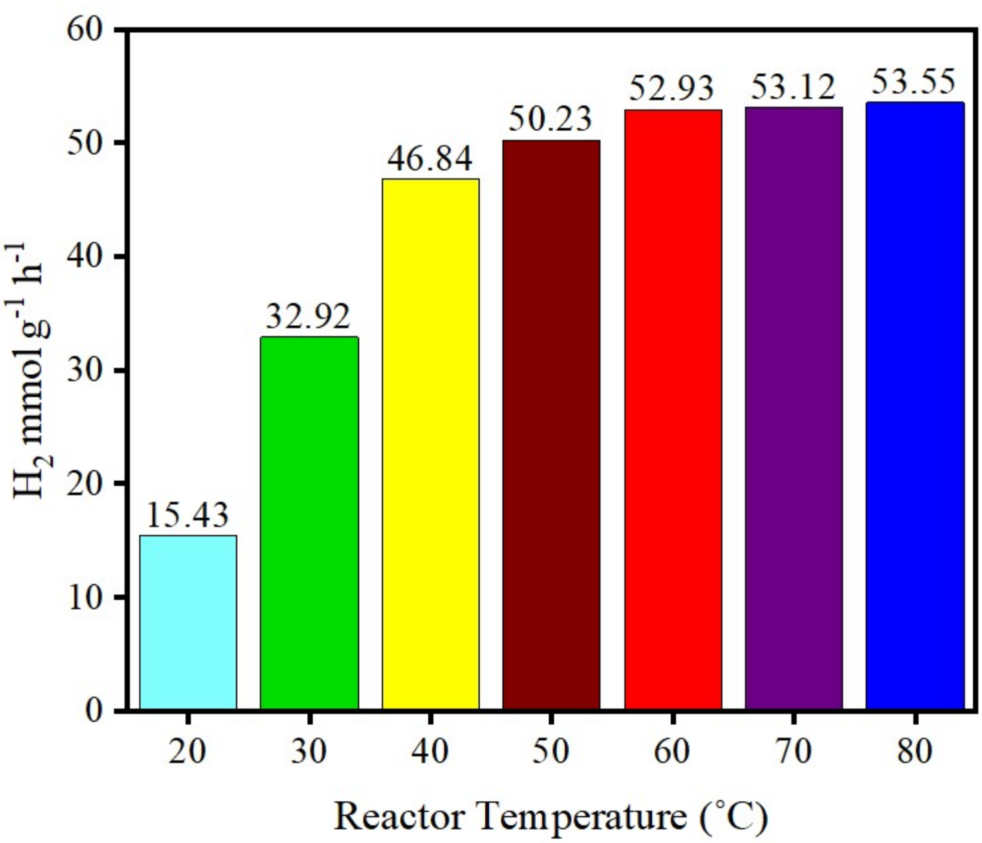

Figure S1: Effect of temperature

pH

Hydrogen ions concentration is another factor which affects the H_2 evolution rate of photocatalyst. Hydrogen gas can be produced in acidic and basic medium but in extreme conditions the activity of photocatalyst reduced [2]. In highly acidic condition photocatalyst starts to degrade which results decrease in the production of hydrogen. In basic medium, hydroxyl ions concentration become high these ions consumes holes and results increased in the hydrogen production [3]. Optimized condition for our research work was 10 pH at this pH maximum hydrogen evolution was observed for results see Figure S2.

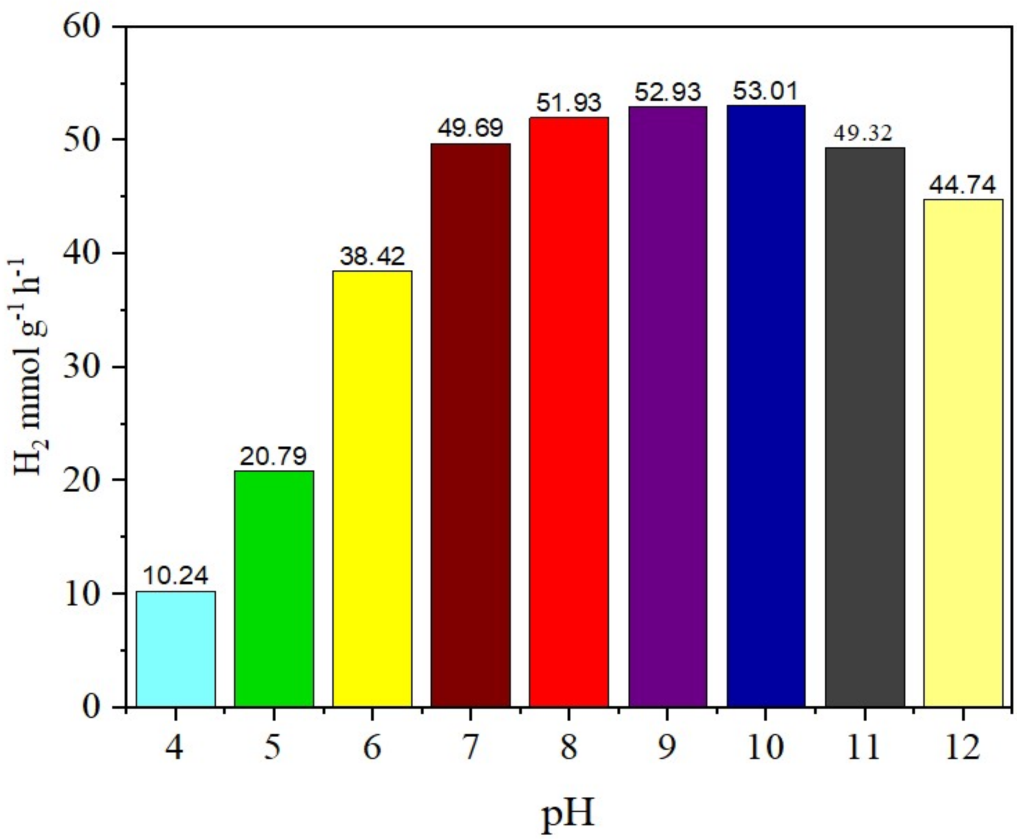

Figure S2: Effect of pH

Light

Presence of light source in all photoreactions is very important, in the absence of light or light source no photoreaction occurred [4]. We carried hydrogen evolution experiment in the presence of solar light. Sun is main source of all types of radiations [5]. During photoreaction as the intensity of light increased hydrogen evolution increased. In the morning, due to low intensity of light hydrogen evolution rate was low, similarly, in the evening light becomes dull and low intensity of light generates less charge carriers due to which less hydrogen produce [6]. During the peak hours of sunlight due to high intensity of light hydrogen evolution becomes high and maximum hydrogen gas produced see Figure S3.

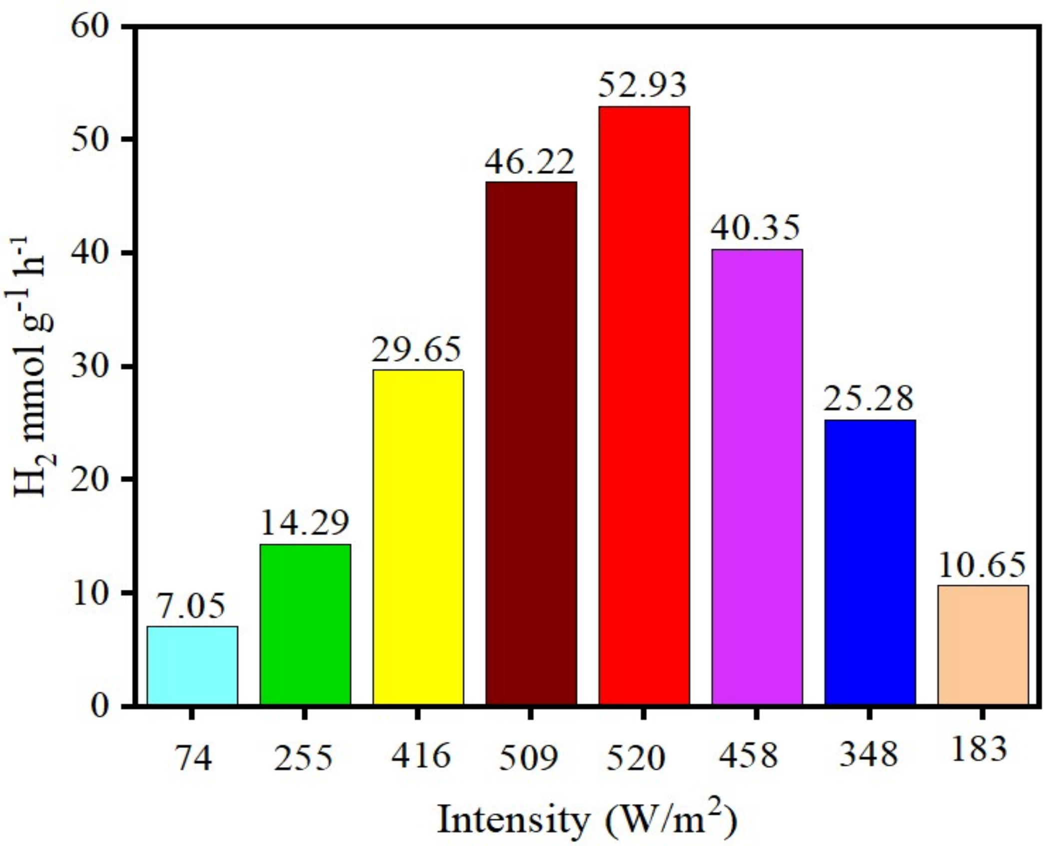

Figure S3: Effect of Light Intensity

Catalyst dose

Amount of catalyst used for the used for the hydrogen evolution experiment also influence the activity pf photocatalyst for hydrogen production. We used optimized and fixed 5 mg amount of photocatalyst for each hydrogen generation experiment. As we increased the amount of photocatalyst the particles starts accumulation[7] and surface of the photocatalyst become occupied with these particles its exposure to the sunlight become less [8] which results decreased in the production of the hydrogen gas see Figure S4.

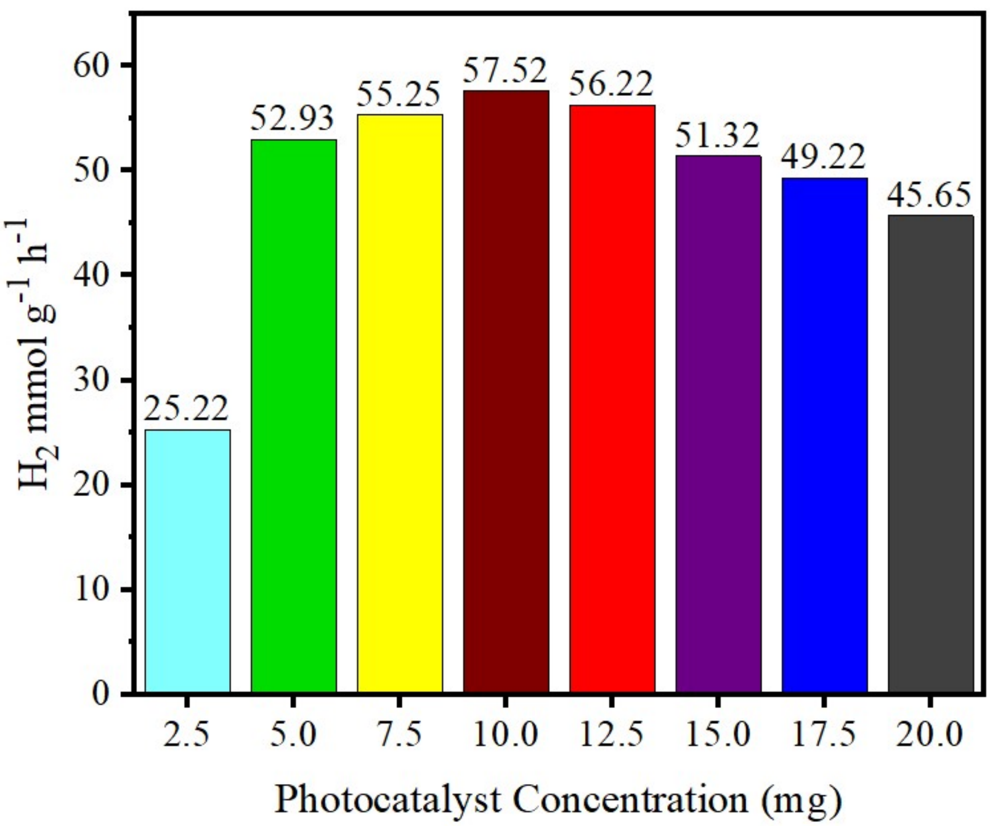

Figure S4: Effect of photocatalyst dose

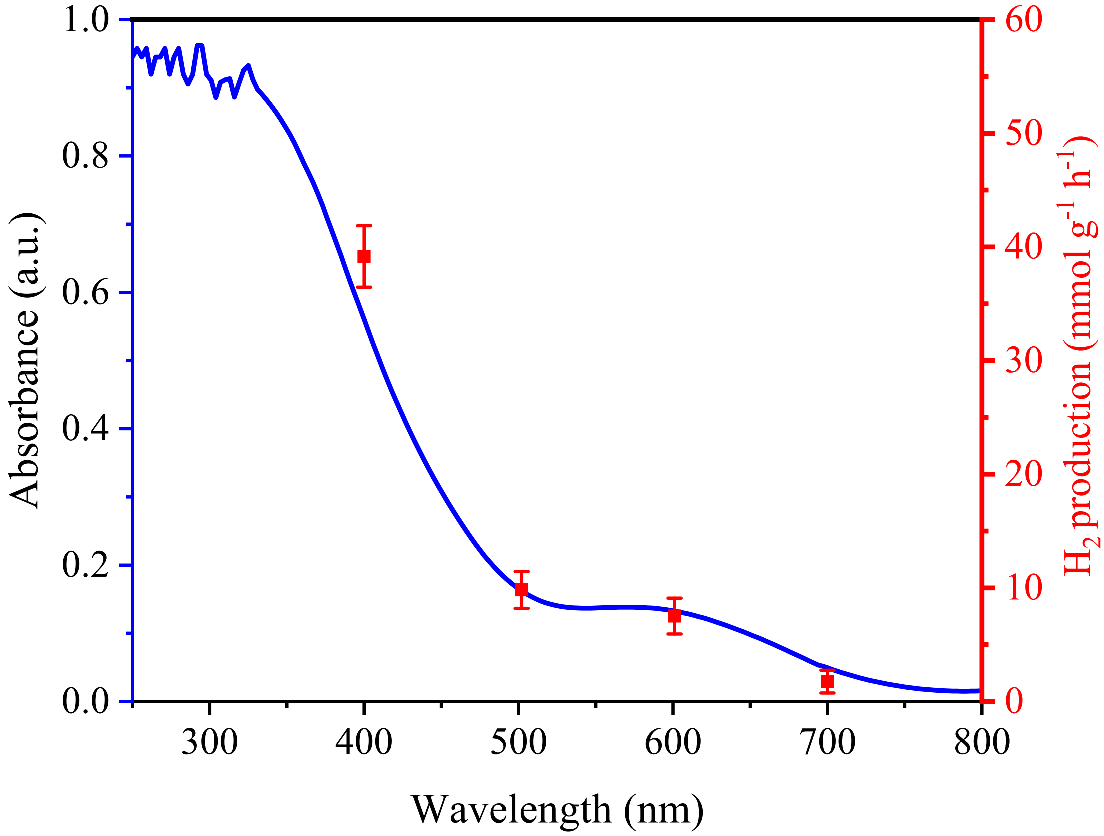

Figure S5: Wavelength dependent activities of Au@Al-$CeVO_4$ photocatalysts.

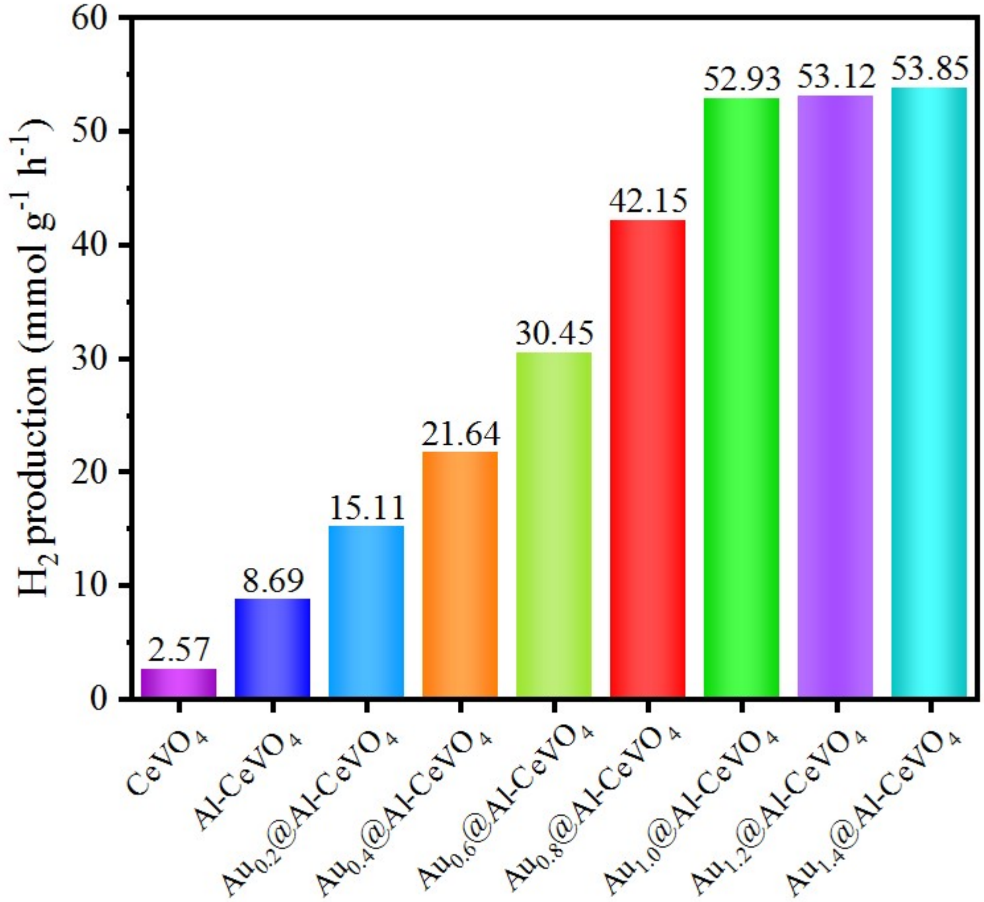

Figure S6: Hydrogen generation activities of as synthesized series of catalysts.

Table S1: The comparison between the concentration of sacrificial reagent and the corresponding H_2 production.

Photocatalysts	Sacrificial reagent* concentration (%)	H_2 evolution (mmol $g^{-1}h^{-1}$)
$Au_{1.0}$@Al–$CeVO_4$	0%	34.55
$Au_{1.0}$@Al–$CeVO_4$	1%	38.43
$Au_{1.0}$@Al–$CeVO_4$	2%	42.78
$Au_{1.0}$@Al–$CeVO_4$	3%	46.11
$Au_{1.0}$@Al–$CeVO_4$	4%	49.45
$Au_{1.0}$@Al–$CeVO_4$	5%	52.93
$Au_{1.0}$@Al–$CeVO_4$	6%	52.99
$Au_{1.0}$@Al–$CeVO_4$	7%	53.22
$Au_{1.0}$@Al–$CeVO_4$	8%	53.43

References

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