A closer look in surface changes of aluminium waste in hydrolysis reaction for green hydrogen production

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Aluminium production and use contributed with 270 Mt of direct CO_2 emissions in 2022 (about 3% of the world's direct industrial CO_2 emissions). [1] It is well known that aluminium can be recycled and reused, but currently that is done to limited extend and still large amounts are landfilled. One rout of use of landfillable aluminium waste is a production of hydrogen via aluminium -water reaction. Taking into account the overall market movement towards the cessation of internal combustion engine production and the decarbonisation of the transport sector, it is clear that development in the direction of synthetic fuel production is necessary. Hydrogen is a crucial raw material used for e-fuel synthesys, alas two major obstacles appear for more rapid implementation. First, high prices and distribution of produced hydrogen. Aluminium waste is produced in every corner of the world, thus secure supply of raw material can be ensured. Secondly, full understanding of hydrolysis via aluminium-water reaction the mitigation of passivated layer is necessary, which entails aluminium oxide and hydroxide growth on Al partciles. One of descriptive reactions can be viewed further [2–4]:

$$2Al + 6H_2O + 2NaOH \rightarrow 2NaAl(OH)_4 + 3H_2 \quad (1)$$
$$NaAl(OH)_4 \rightarrow NaOH + Al(OH)_3 \quad (2)$$

In the scope of the work aluminium reaction with alklali electrolyte is investigated using various surface and bulk investigative methods including electrochemical corrosion tests compared to generated hydrogen. H_2 generation where carried out during the reaction process, the ratio of $Al(OH)_3$ and Al tracked through out the reaction as well as detailed bulk and localized pH changes is investigated. The reaction was carried out in 0.5M NaOH using pressed tablets of Aluminium waste. Conclusions are drawn based on detailed understanding of hydrolysis and aluminium surface changes.

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