

## **LIFE BITMAPS project for the biodegradation of Tetramethylammonium Hydroxide (TMAH) in the wastewaters of semiconductor production: neutralization of waste by CO<sub>2</sub> in lab and pilot scale**

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In semiconductors production the photoimpression stage of microchips is an important key point and different kinds of chemical reactants are used for this goal. In particular a mixture of organic compounds known together as photoresist and a highly basic solution of a quaternary ammonium salt, Tetramethylammonium hydroxide (TMAH), are usually utilised. These reactants are concentrated and disposed after the photoimpression stage with high disposal cost and with some important environmental impact on aquatic environment: different death cases have been recorded in Taiwan due TMAH utilization and several studies have underlined that 0.2mg/L of TMAH in the aquatic environment can originate problems on aquatic living organisms. Nevertheless, electronic industry has highly increased the amount of its microchip production and according with this behavior the quantity of wastes related with this kind of production is rapidly growing. Furthermore, in Europe, statistical data have shown that about 12% of water is used for this industrial sector. For this reason, EU is greatly encouraging and funding research activities on wastewater treatment, waste and water recycling for this industrial sector being always more important to study several environmental technologies that can reduce its impact on the environment reducing at the same time its disposal cost.

In the present work an integrated and multistage innovative process to treat industrial wastewater originated by semiconductors production processes is described. The research activities are carried out in the ambit a European project named LIFE BITMAPS involving 3 companies (LFoundry, BFC Srl and BME Srl) and one research institution (University of L'Aquila) in Italy (<http://www.lifebitmaps.eu/bme.html>).

The overall patented process considers several steps: neutralization of TMAH waste by H<sub>2</sub>SO<sub>4</sub>, biological aerobic degradation of TMAH into ammonium and final treatment in a standard active sludge treatment plant (denitrification, nitrification and organic carbon reduction).

In the present work the successfully use of CO<sub>2</sub> has been tested for the neutralization of TMAH waste eliminating the use o mineral acid like H<sub>2</sub>SO<sub>4</sub>. Experimental tests have been carried out in lab and pilot scale. Its use permit several advantages:

- Use of more safe reagent for the neutralization of this basic waste before the biological process;
- Reduction of the global environmental impact due to the elimination of H<sub>2</sub>SO<sub>4</sub> (LCA);
- Presence of ammonium carbonate solution that can be sent to the final aerobic biodegradation taking in consideration that nitrification step involves autotrophic microorganism;
- The elimination of H<sub>2</sub>SO<sub>4</sub> in the neutralization step permits to control the strict limits discharge in terms of sulphate concentrations in the environment;

Experimental test carried out in lab and pilot scale permitted to demonstrate the technical feasibility of the neutralization process by using CO<sub>2</sub>. The pilot plant to realize all the steps involved in the process is under construction to demonstrate the feasibility of overall process and to identify technological aspects on a real scale, including its effect on wwt plant of the industrial company. The experimental tests on this scale will be carried out in middle 2018.