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Study of the carbon materials formation during the plasmolysis of methane in a gliding arc discharge

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Gliding arc discharge (GAD) is recognized to be efficient for gas conversion due to its "warm" features, which originate from the discharge properties that fall between those of cold plasma and thermal plasma [1]. In addition, GAD offers several benefits over other plasma techniques, such as the ability to operate under atmospheric pressure, high flexibility, and decent performance for several conversion processes. Particularly, GAD can be employed in plasma-assisted hydrocarbon plasmolysis, which is considered as a promising path towards H_2 production since the thermodynamic requirements of these reactions are significantly lower than those of water electrolysis. In this process, the decomposition of the hydrocarbon feedstock leads to the production of H_2 and carbon-based by-products. If extensively reported, the synthesis of these carbon-based by-products in GAD is poorly investigated [2,3].

In the present work, we aim to contribute to a better understanding of the synthesis mechanisms of these by-products in Ar/CH_4 plasma generated in a two-dimensional gliding arc reactor at atmospheric pressure. The effects of the total gas flow rate, CH_4 content and discharge current on the morphology, structure and thermal stability of the generated carbon materials are studied using scanning electron microscope (SEM), Raman spectroscopy and thermogravimetric analysis (TGA). Our results show that at higher flow rates, the generated carbon nanomaterials predominantly exhibit a graphene-based structure. At lower flow rates, the degree of graphitization varies with current, being lower at 50 mA but higher at 75 mA. SEM images indicate that graphene is the main morphology at higher flow rates, while both graphene and spherical carbon are present at lower flow rates. Additionally, solid carbon produced at higher methane content and 50 mA demonstrates greater thermal instability and more impurities.

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