Over the past decades, extensive research has been done regarding renewable energy. Thermal catalytic decomposition of methane is one of the reactions that has gained a lot of attention. During this reaction, pure hydrogen is produced without the emission of CO2. In addition, valuable carbon nanomaterials, such as nanofibers (CNF) and carbon nanotubes (CNT), are grown. These carbon materials have interesting properties, e.g. high electron conductivity, mechanical and thermal stability.[1] The carbon nanostructure growth is influenced by many parameters. Therefore, the exact mechanism is not fully understood. Figure 1 shows a schematic overview of a proposed mechanism.

In this project, we aim to construct a conceptional framework to understand what changes are induced by the different parameters. Carbon nanofiber formation from methane decomposition over NiCu/C catalysts is studied using a thermogravimetric analyzer (TGA). First, we investigated how the carbon yield is influenced by reaction parameters.[2] Based on experiments with varying temperature, two temperature regimes were identified. Different kinetic parameters were derived for the two regimes and also different carbon structures were formed. We postulate that at lower temperature the methane dissociation is rate limiting, while at higher temperature the carbon formation plays a more critical role. Secondly, we directly compared time-resolved overall carbon growth rates in the TGA with nanometer-scale carbon growth observations in situ TEM.[3] Good quantitative agreement in time-dependent growth rates allowed for validation of the electron microscopy measurements and detailed insight into the contribution of individual catalyst nanoparticles. The smallest particles did not grow fibers, while larger particles (8–16 nm) exhibited high carbon growth rates but deactivated quickly. Even larger particles grew carbon slowly without significant deactivation.[3]