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In situ TEM Observation of Nanoparticles Formation during Carbothermal Shock

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The synthesis of nanoparticles is commonly through wet chemical process as it is simple and easy to have large scale production[1]. However, additives like reductants and surfactants are always needed during preparation, which after synthesis, those residuals are hard to remove and may cause side effects[2]. In addition, the composition and mixability of each elements are hard to control if multielement nanoparticles needs to be synthesized[3].

Recently, a new additive free approach– carbothermal shock (CTS)[4], could rapidly achieve ~2000K on metal salts loaded carbon substrate, decomposes the salts and achieves uniform multicomponent nanoparticles on carbon substrate. Since the heating period is only tens of milliseconds, it is hard to review the underlying particle formation mechanism with conventional ways.

In situ TEM is a unique and advanced technique that could capture kinetic process with high spatial and time resolution. Thus, the CTS method can be well mimicked and unveiled through this method. In this study, through the in situ TEM test, we successfully observed the nanoparticles formation on carbon substrate during CTS. It was shown that the interaction between substrate and nanoparticles is the dominate factor for the nanoparticles to have uniform dispersion and high stability. The uniform and ultra-small Pt nanoparticles on carbon substrate after CTS was captured and shown in Figure 1. This finding could not only guide the further studies on CTS based methods but also give new direction on other high temperature synthesis methods.

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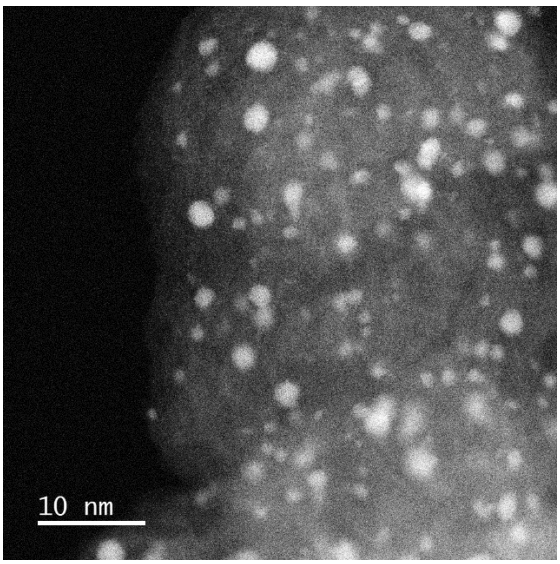

Figure 1. HAADF-STEM image of ultra-small Pt nanoparticles dispersed on carbon substrate through CTS method.

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