Scaling Up Identical-Location Microscopy to Assess Electrocatalyst Degradation

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Designing durable fuel cell electrocatalysts requires understanding how individual nanoparticles evolve under operating conditions, yet ex situ imaging obscures important particle-to-particle differences by averaging over large ensembles. Identical-location scanning transmission electron microscopy (IL-STEM) enables direct tracking of the same nanoparticles before and after degradation [1] but has typically been limited to relatively small datasets.

In this work, we expand IL-STEM to hundreds of Pt-Co nanoparticles under electrochemical stress. We develop a three-stage image analysis combining particle detection using machine learning, particle tracking, and classification of degradation mechanisms. This approach quantifies degradation pathways (Figure 1) across statistically relevant particle populations and is transferrable to other systems where understanding structure-stability relationships is key to a knowledge-driven materials design.

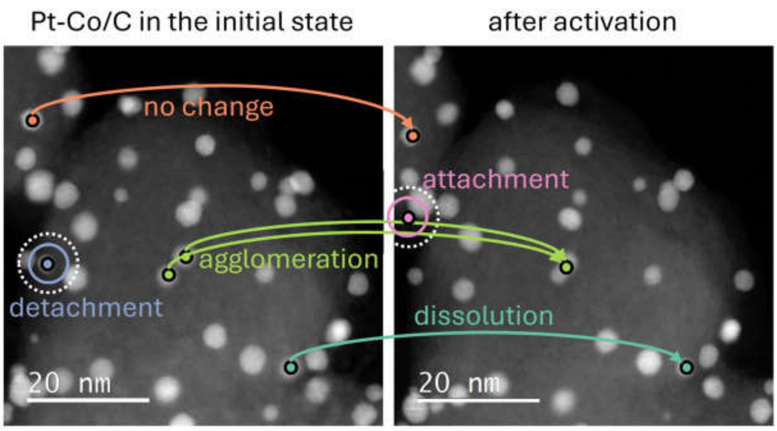

Figure 1. IL-STEM images of carbon-supported Pt-Co nanoparticles before and after potential cycling activation. Colored markers denote degradation events.

1. A. O. Godoy, M. Birnbach, J. Jankovic, *Small Methods*, **2025**, *e02201*.

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