

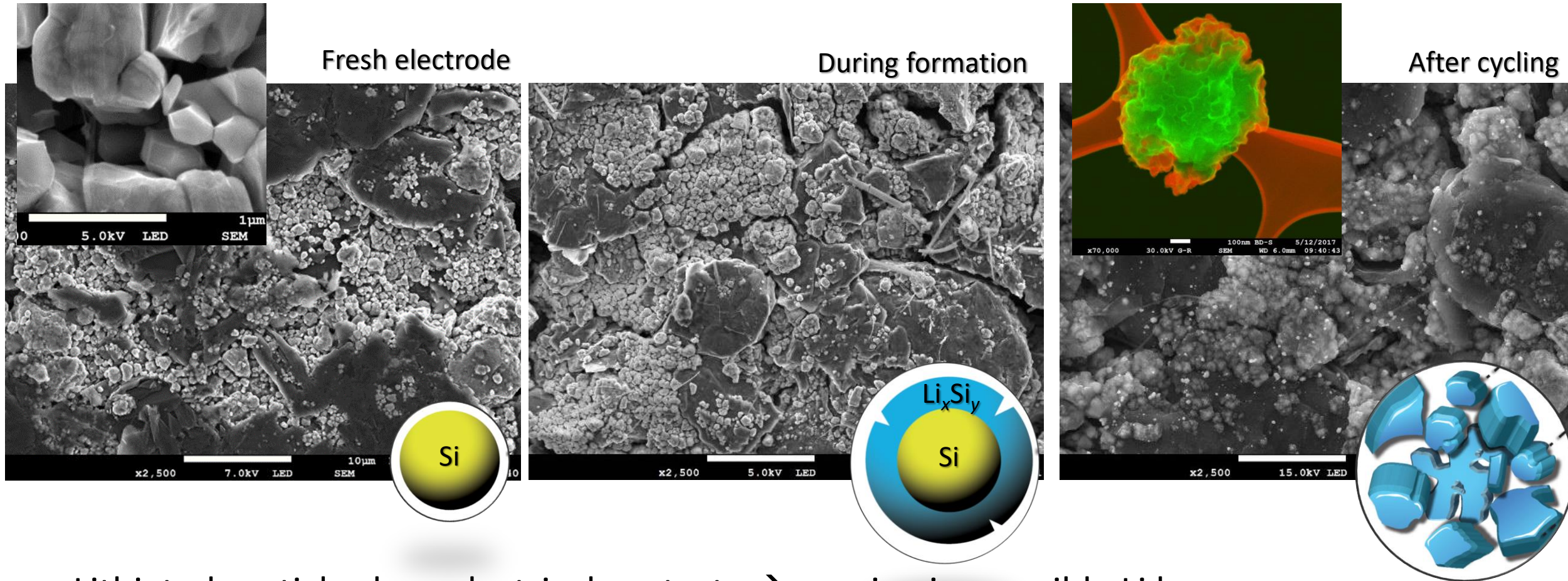
**BLACK DIAMOND
STRUCTURES™**

Investigation of High Performance Nano-Solutions for Si based Anodes



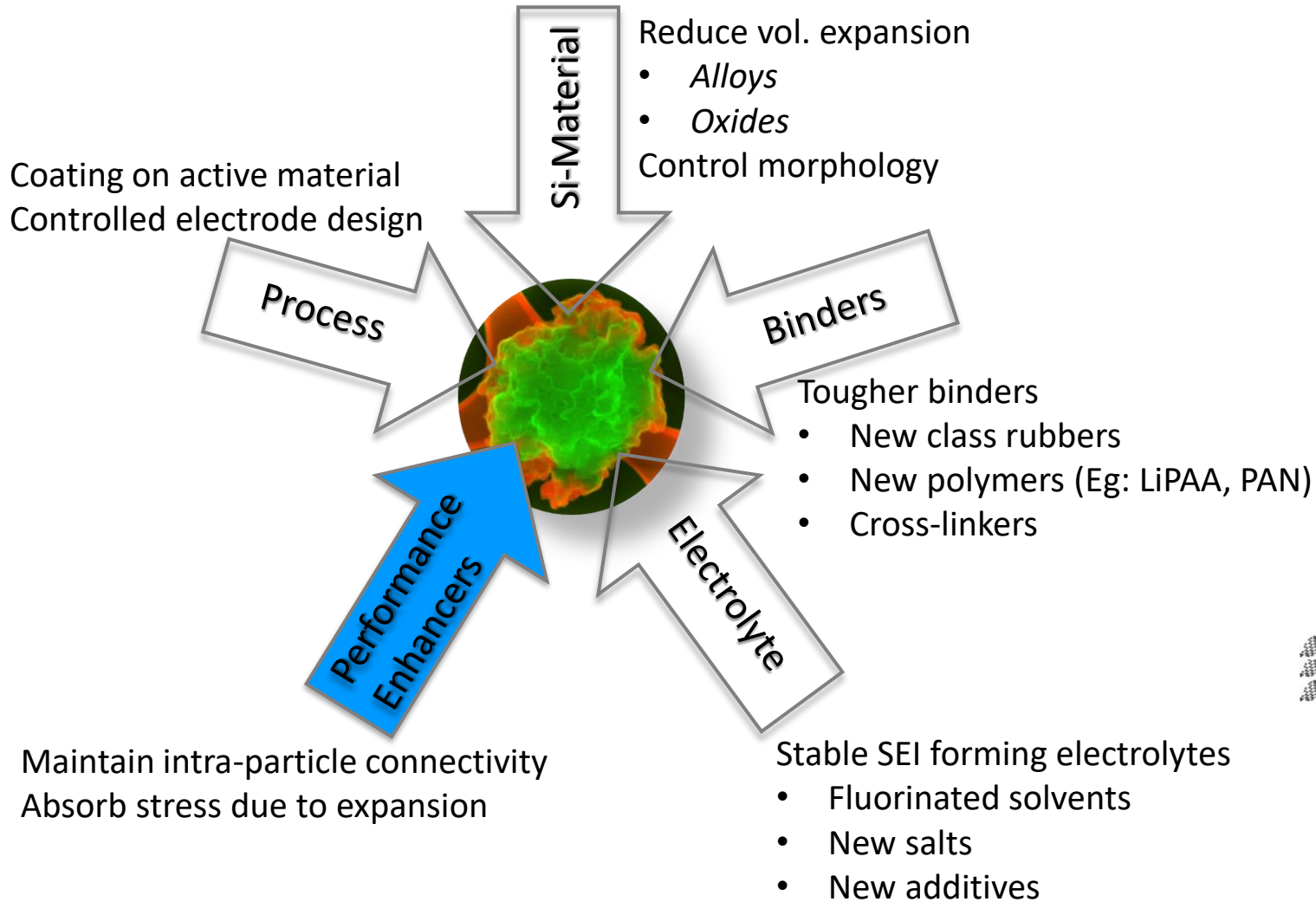
Vinay Bhat, PhD – Principal Scientist
September 2017

Typical Silicon Anodes: Poor Cycle Life Challenge

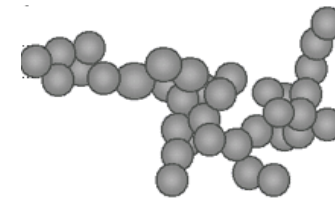


- Lithiated particles lose electrical contacts → causing irreversible Li loss
- Stress in electrode → bounce back and continuous impedance build-up
- SEI formation on fresh fractured surface → Li loss

Addressing the Challenge



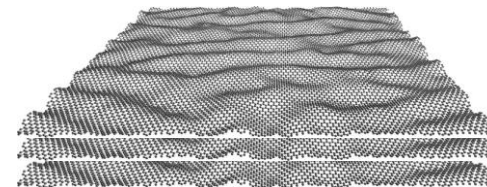
Carbon Black



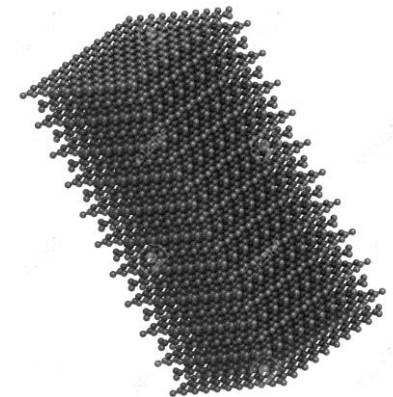
Carbon Nanotubes



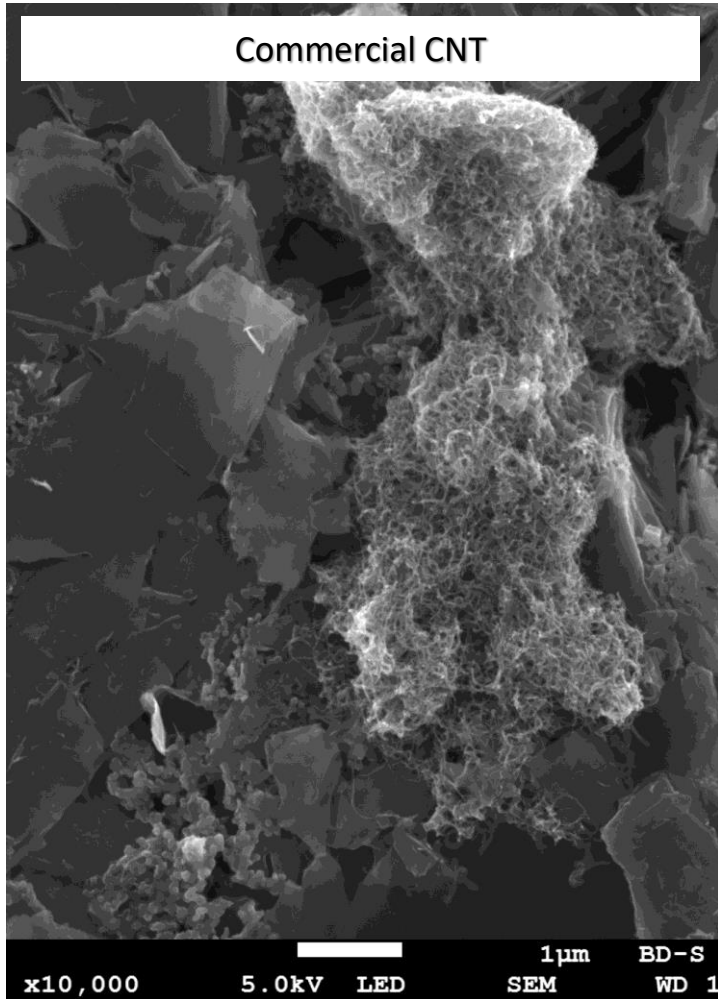
Graphene



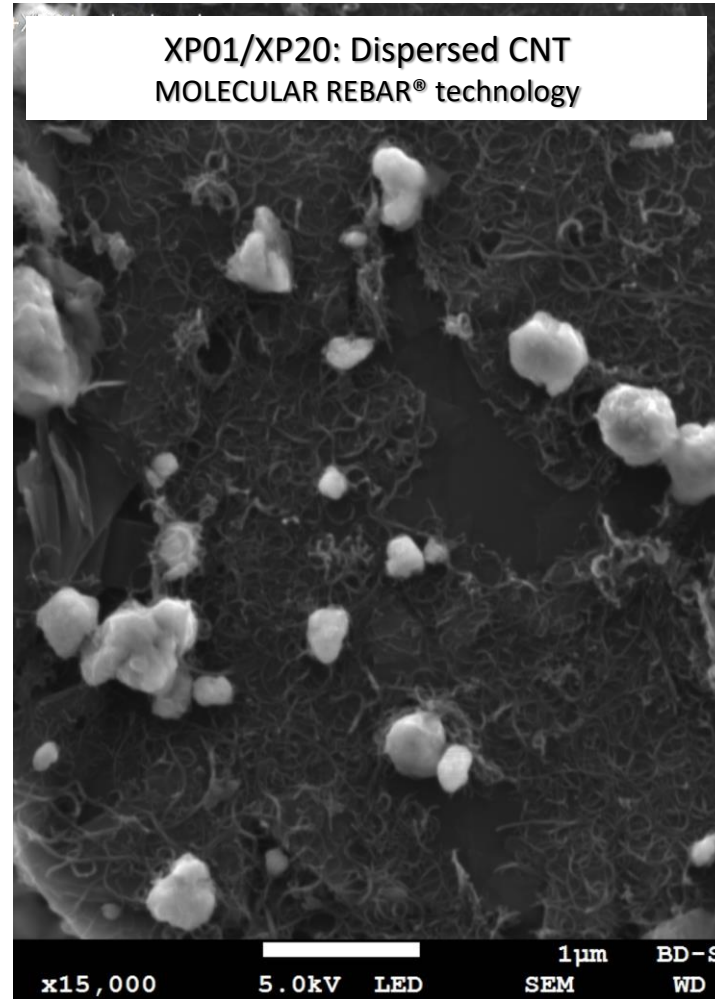
Graphite/Hard Carbon



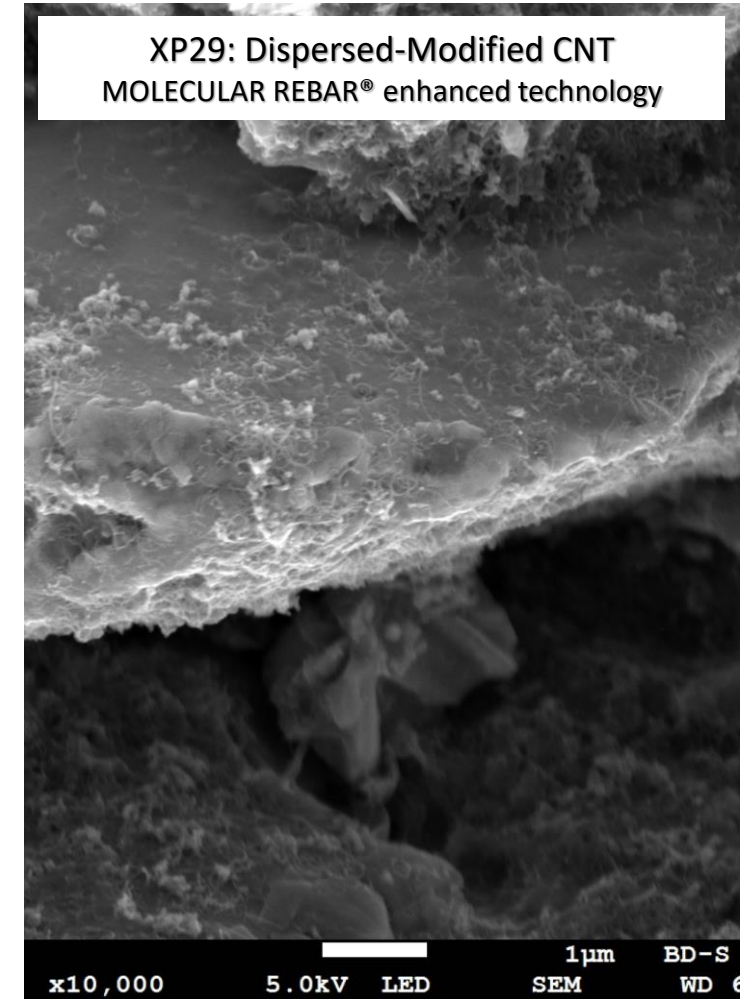
Effective Use of CNT



- Acts as particle/agglomerate
- No full advantage of 1D structure of CNT

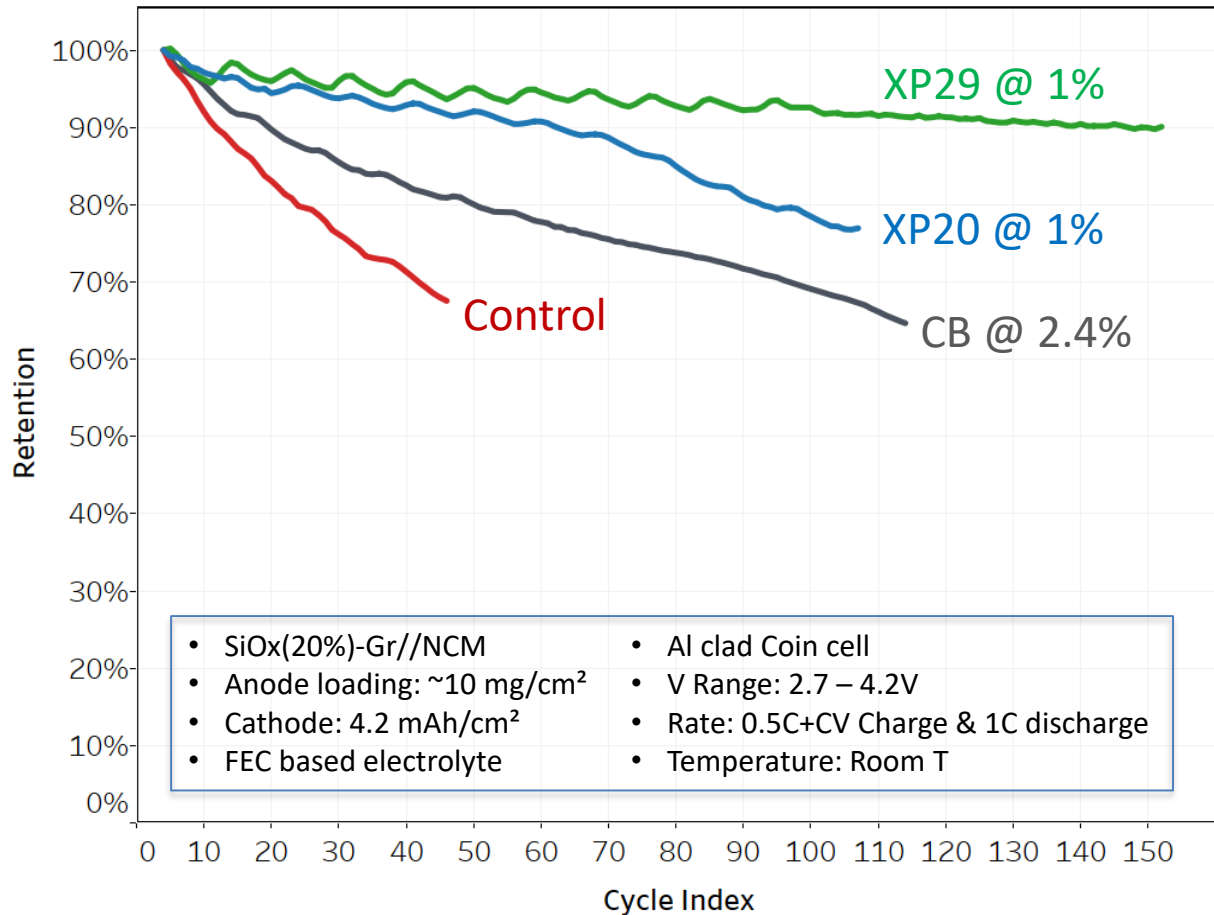


- Better interaction with active particles



- Strong interaction with binder, SiO_x and SiA
- Improve toughness of binder
- Maintain contact with active particles

Influence of Different Carbons

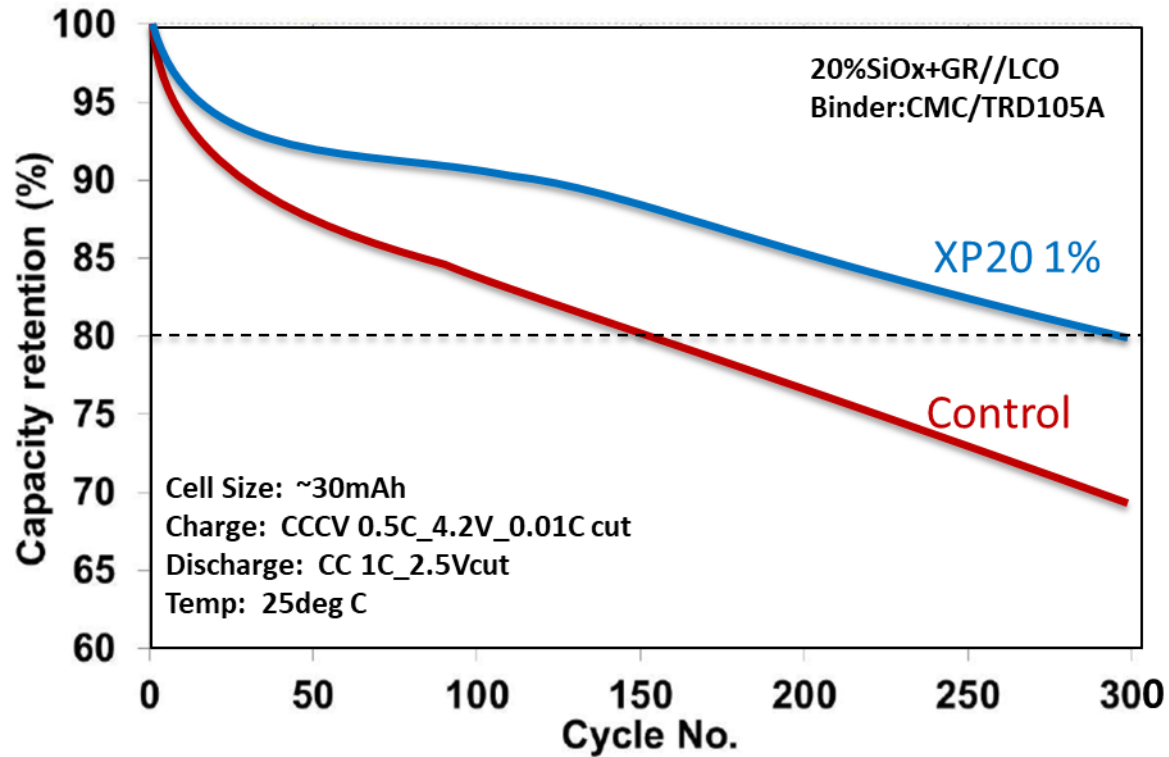


- Cycle life is a challenge in Si-based anodes
- CB improved conductivity → improve cycle life
- Dispersed CNT provides toughness and conductivity
- Dispersed-Modified CNT in addition brings strong chemical interaction with binder and Si-based materials

Strong interactions between Silicon based materials, binders, & CNT are critical to achieve improved performance

Compatibility with Different Binder and Si Systems

Test conducted with JSR TRD105A SBR binder



Relative cycle life improvement with our solutions:

	SiOx	Si-Alloy
CMC/SBR based	100%	>300%
LiPAA based	>100%	>50%

Our Solutions can enable Silicon based Anodes!

Who We Are

Black Diamond Structures, a developer, manufacturer, and marketer of innovative nanomaterial products and solutions based on revolutionary carbon nanotube (CNT) technology, **MOLECULAR REBAR®**

Our Partners



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