Opportunity
Solar panel array efficiency can decrease up to 50% over 6 months due to particle accumulation.\(^1\)

Effective surface particle removal is a problem across this and many other applications.

Motivation
Previous research showed that viscoelastic fluids are more effective at removing particles adhered by Van der Waals forces than purely Newtonian fluids.\(^2\)

Setup
Siphon pipe
Viscoelastic fluid
Particle

Results
Design Goals
• Handheld size
• Vacuum sealing mechanism
• Modular nozzle body
• Low cost

Testing
A 0.1 wt% UCARFLOC polyethylene oxide polymer solution (8 million MW) was used as the viscoelastic fluid.

Silica particles (<30 \(\mu\)m) were adhered to glass substrates for preliminary particle removal testing. Water and the UCARFLOC solution were both tested with the prototype nozzle at a 23.5 ml/s flow rate.

Nozzle Design
Prototype
• Off-the-shelf materials
• Lacks vacuum sealing, Silly Putty used

3D printed
• Designed in SolidWorks
• Printed with Makerbot Replicator 2X
• Rapid, cheap prototyping
• Threaded fittings for hose hardware

Future Work
Continue particle removal testing. Begin testing with 3D printed nozzle once vacuum seal is fixed. Explore role of nozzle design variables on particle removal efficiency.

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What is a viscoelastic fluid?
• Exhibits liquid (viscous) and solid (elastic) properties
• Non-linear relationship between shear stress and shear rate

Nozzle body
SolidWorks model
Impinging jet mesh
Makerbot Replicator 2X

Water
Before
0.5 mm
After
0.5 mm
Removal
~0%

Viscoelastic
Before
0.5 mm
After
0.5 mm
Removal
~80%