Diamonds in Washington, Volcanic Dust in Hawaii, Dark Matter and Gravity Waves from LIGO: Surface Metrology and LIDT Using First Contact Polymers on Precision Optics, Sensors and Nanostructures

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Research in our labs has resulted in novel polymeric stripcoatings that are applied as a liquid and subsequently peeled off the substrate as a solid film. These polymer blend solutions safely clean and protect a wide variety of nanostructured surfaces and leave the surface almost atomically clean and "space ready"(NASA). Contaminant removal was monitored by a variety of techniques including Nomarski, Atomic Force and Scanning Electron Microscopy as well as XPS. In addition, our data demonstrates that the material safely removes particulate contamination and finger oils from microstructures such as the 300nm wide lines on diffraction gratings and similar submicron features on Si wafers. These nanosurfaces are also replicated with high fidelity down to well below 50nm.

Contamination control is a fundamental and limiting issue in many of the worlds largest physics, engineering and chemistry projects. Applications of these polymer systems range from the astronomical and astrophysical to lithography, microscopy and surface chemistry. Data from metrology we and others have performed will be discussed using these designer polymers on high power laser optics; the Hope Diamond in Washington; Advanced LIGO optics, the primary mirrors of the W.M. Keck telescope on Mauna Kea in Hawaii; mirrors for Hubble, James Webb and other space surfaces; CCD's for the 520 megapixel Dark Energy Survey Camera built at Fermilab as well as detector surfaces used at 50 milliKelvin in the cryogenic search for dark matter. Vandenburg Air Force Base Optics Depot has published a $1 million Cost Avoidance Initiative corporate-wide within ITT, the Western Range Optics Depot maintenance contractor, based on use of our polymers for protection during storage as well as cleaning. In February 2016 at the 10.7 meter Gran Canarias Telescopio (GTC) on La Palma, Canary Islands successful field tests restored primary segments to like new reflectivity removing incredibly thick layers of Sahara dust.

We have built a LabVIEW controlled, semi-automated nanosecond YAG Laser Induced Damage Thresholds (LIDT) system and have preliminary results demonstrating increased LIDTs on ZnSe and other surfaces and coatings before and after protection and cleaning with First Contact Polymer stripcoatings. We believe this technology can enables the creation of zero defect coatings with maximal LIDT and scatter, especially if, for example, LIDT's of nonlinear optical crystal surfaces are limited by surface LIDT's that are 100-1000X lower than bulk processes and can be mitigated by cleaning with First Contact Polymers. We report YAG LIDTs after removing fingerprints and dust that are comparable to a pristine crystal surface and in some cases are significantly higher than before cleaning.