Studying the Medium Range Order of Amorphous Coatings

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The Laser Interferometer Gravitational-Wave Observatory (LIGO), while able to detect gravitational waves, has a limiting thermal noise source from its mirror coatings. We have seen that in experiment annealing tantala based amorphous coatings can lower the mechanical loss of those coatings at room temperature. When studying the pair distribution functions (PDFs) of these different amorphous coatings annealed at different temperatures, we see that the largest differences occur in the medium range of the PDF; where medium range is defined as the pair distances greater than 5 angstroms. Thus, to understand the effects that annealing has on mechanical loss we must understand the effects of annealing on the medium range order of our structures. In this work, we present an extensive study on the medium range order of pure tantala, zirconia-doped tantala, and pure niobia. All of these materials are possible candidates for future LIGO gravitational wave detector mirror coatings. We focus our attention on long chains and rings connecting pairs of atoms responsible for specific peaks in the PDFs.