# From underground to outer space: new applications for laser cleaning in mineralogy

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Varying the parameters such as pulse duration, fluence, and pulse frequency of conservation lasers can result in successful cleaning of mineralogical materials such as quartz crystals coated with dark orange iron oxide films that were mined from iron-rich clays, and corroded iron meteorites. Quartz is typically desirable for specimen collections and commercial applications as a pure clean crystal. One of the most common methods for cleaning quartz involves using hot acidic solutions such as oxalic acid. Using 1064nm laser pulses may provide a less aggressive alternative for removing the oxide films from the crystals. Meteorites provide scientists with valuable information about the geologic past of our own planet and our neighbors in the Solar System. Iron meteorite samples are often cut and polished to reveal cross sections that display crystalline structures. However, via moisture introduced from the environment, wet polishing methods, inappropriate handling, and exposure to oxygen, the surfaces of these iron-rich samples can easily oxidize due to the formation of various iron oxy-hydroxide-hydrates, sometimes including the further oxidation promoting akaganeite ($Fe^{3+}O(OH,Cl)$). The current method for removing rust from these samples involves additional wet polishing, which introduces moisture that will ultimately react with chlorine contaminants and result in additional surface oxidation. Further, wet polishing involves the removal of a layer of material from the specimen—an irreversible, destructive treatment. The Smithsonian's National Museum of Natural History Department of Mineral Sciences, has a number of meteorite samples that are currently limited in scientific utility due to oxidized surfaces, coupled with the concern that wet polishing could prove too aggressive. The use of 1064nm laser pulses at various durations and fluences is explored as a means to remove the oxide coating from these meteorites without the removal of a significant layer of specimen material and the introduction of additional moisture.