Laser peening for preventing pipe corrosion and failure

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Main Objective

This project is to develop a portable high speed laser shock peening equipment, which could be utilized to improve the corrosion resistance of pipeline steels via introducing surface compressive residual stress to the constructed pipeline transportation system.

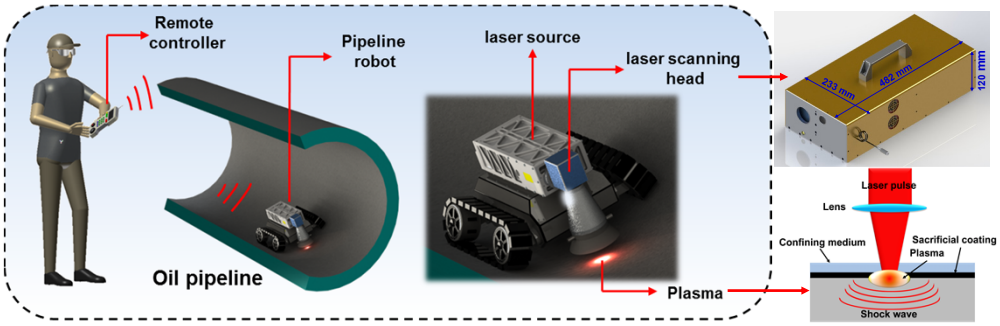

Figure 1. Schematic of the basic engineering solutions of on-site high speed laser peening prototype system for pipelines

Project Approaches/Scopes

The major tasks to achieve the objective of this proposed project are as follows:

- Develop low energy laser peening for pipeline steels
- Investigate plasma and shock wave behavior control to enhance peening effect
- Optimize peening parameters to prevent corrosion and failure of pipeline steels
- Design an on-site high speed laser peening system for pipelines

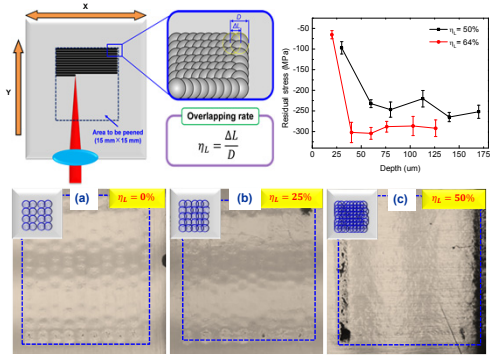

Figure 2. Laser peening effect with different overlapping rates

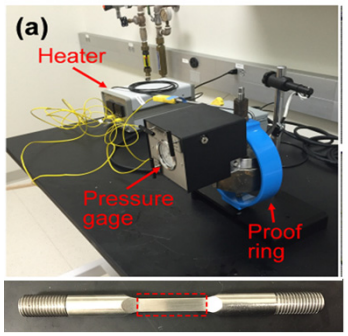

Figure 3. The SCC test equipment and sample

Expected Results or Results to Date

1. Low energy and compact Nd:YAG laser peening system was established and tested
   - High speed, large processing area, flexible, ease of integration and maintenance free
2. Important peening processing parameters are optimized, including the laser pulse energy, overlapping rate, impact time, and sacrificial coating condition
   - Low surface damage, low surface roughness, and optimal peening effect are achieved
3. Evaluation and test were carried out to confirm the peening effect
   - Sufficient residual stress is achieved – about -500 Mpa
   - Microstructure – the grain size is refined
   - Mechanical property – surface hardness is enhanced
   - Corrosive resistance is improved significantly
4. A lab-based portable laser peening system for pipeline industry is designed and being fabricated
   - With the capabilities of laser peening, laser cleaning, being remotely controllable, being programmable, and real-time monitoring

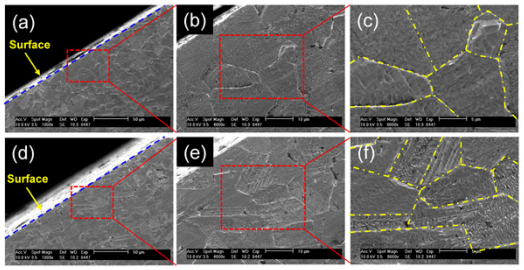

Figure 4. The microstructure of 304 stainless steel before (a-c) and after (d-f) laser shock peening

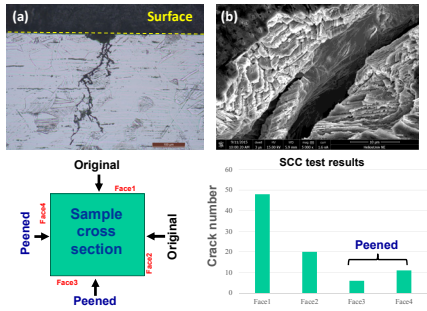

Figure 5. Improvement of SCC corrosion resistance after laser peening

Acknowledgments

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Public Project Page

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