

SIZE-SELECTIVE CONTRASTING OF SURFACE DEFECTS USING PHOTOLUMINESCENT METAL NANOPARTICLES

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Abstract

Pipeline corrosion, especially in regions with a harsh climate such as Ural or Siberia in Russia, is a significant problem for oil and gas transport infrastructure. Disastrous destruction of pipelines can be prevented if the corrosion is detected early by non-destructive testing (NDT) methods. There are a lot of NDT methods available for corrosion monitoring, but they suffer from drawbacks. For example, they are not applicable for rough surfaces, their contrast ability is low and a size-selective contrasting of nano-sized corrosion defects is unavailable.

We have developed a modified penetrant method in which a visual inspection is replaced by a mapping of nanocracks contrasted by the penetrant – photoluminescent metal nanoparticles. Nanoparticles fill in nanocracks that are wider than the nanoparticles diameter. After that the nanoparticles can be detected by femtosecond laser-induced photoluminescence and second harmonic generation, thus enabling size-selective contrasting of surface defects.

This method allows selectively contrasting of nanocracks with a different width by changing size of nanoparticles. Furthermore, it is possible to distinguish deep cracks from shallow surface defects. Preliminary results suggest to be applicable for testing of other high-loaded materials such as outer skin of aircraft or spacecraft.

Keywords: Nanoparticles, femtosecond laser, corrosion, non-destructive testing

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