A114 Discrimination of Fiber Reinforced Plastics (FRP) Using Thermogravimetry (TG)

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After attending this presentation, attendees will understand how the analyses of samples concerning collision cases between ships are performed in Japan. In addition, this presentation will introduce the method for identification of Fiber/Glass Reinforced Plastics (FRP/or GRP) using Thermogravimetry (TG).

This presentation will impact the forensic community by demonstrating a method to discriminate between thermoset polymers not only for ships collision cases but also for land criminal cases since TG has not often been used by the forensic community.

In Japan, there are on the average 30 cases a year of hit-and-run collision accidents between ships, as well as some accidents where the crew on duty does not recognize the collision. For investigation of these cases, paints which are transferred from the hull of one ship to another would be the most valuable type of evidence. Paint samples taken from both ships are observed to determine if they have the same appearance (sequence of layers, colors, etc.). Each layer is then analyzed and compared using Fourier-transform infrared microscopy and scanning electron microscope-energy dispersive X-ray spectroscopy.

Smaller vessels such as fishing and pleasure vessels are commonly built of Fiber Reinforced Plastics (FRP) and are surfaced with a “gel coat” often colored white. When FRP ships collide with other ships, pieces of gel coat (sometimes with paints) are likely to be transferred and collected as samples. The gel coat is an unsaturated polyester (UP) resin-based plastic matrix with some pigments and additives. There are traditionally two major types of UP resin used for vessel construction; orthophthalic (ortho); and isophthalic (iso). The major pigment is always TiO_2 because of its color and there are also other pigments/fillers (clay, talc, etc.) included in small amounts. When ships get older, they sometimes have single or multi-layered paint, but newly built FRP ships have no paints on the gel coat (except for antifouling paint on the bottom of the hull). Therefore, it has been recognized to be difficult to characterize gel coats. This presentation will examine the data of gel coat samples which were analyzed in 28 collision cases since 2007. Among the samples from 28 cases, 14 were ortho (10 had paint layer(s) on their surfaces), 13 were iso (four painted), and one was an other type of polymer resin (not painted). Although all 14 ortho samples, six of the iso samples, and the one resin were discriminated by their own IR spectra or by variety of their paint layers, it was difficult to distinguish two pairs and a group (containing four samples) of iso’s without paint on their surface. In order to characterize these gel coats, a further analysis method was required.

TG is a popular method for evaluating polymer properties; however, the use of this technique for forensic purpose has rarely been reported. In this presentation, the result of the TG of gel coats will be introduced. The primary goal of this study was to optimize the experimental conditions; atmosphere, temperature range, heating rate, and sample amount. Several gel coat samples collected from dockyards were analyzed with thermogravimetric differential thermal analyzer (TG-DTA). All of the thermogravimetric curves showed at least three degradation processes under air atmosphere. By comparing the temperatures corresponding to the maximum rate degradations, some pairs of samples which have no differences in IR spectra and elemental analysis had distinct discrepancies. The differences between samples may be attributed to the minor additives and cross-linking structure of polymers.

FRP, TG, Paint

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