Supporting Information

Optical scattering from graphene foam for oil imaging/sensing

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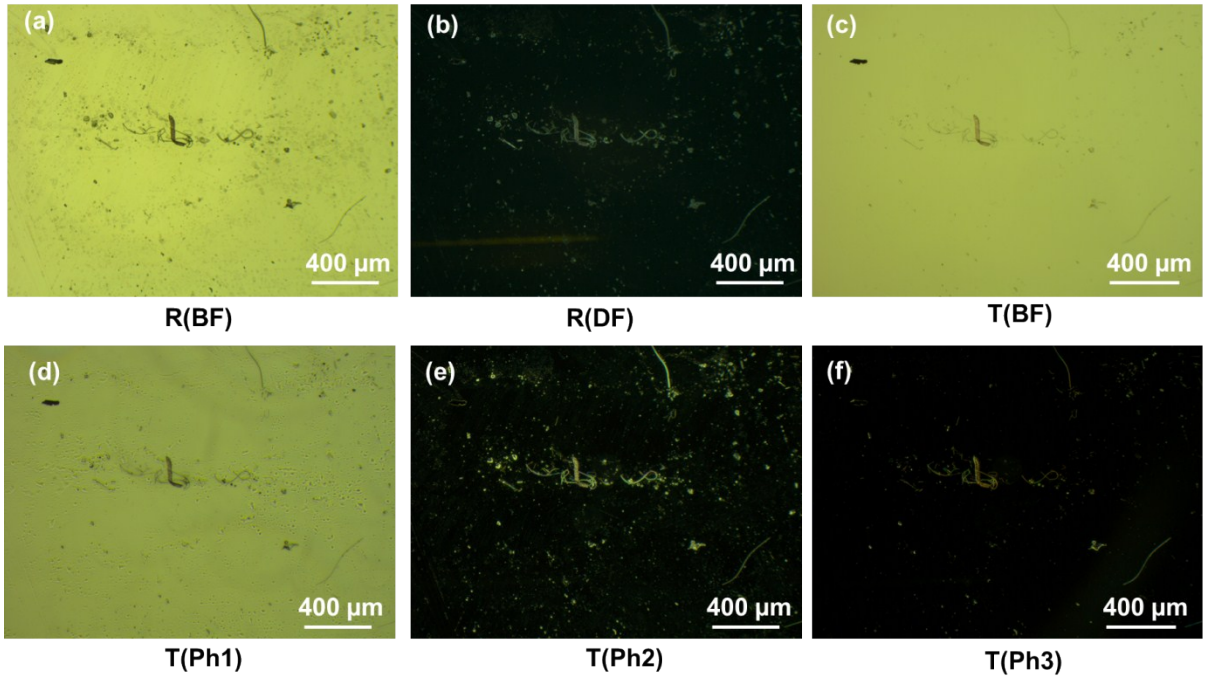
Different detection modes for Zeiss A1 microscope

The microscope used for detection in this paper has different detection modes, as illustrated in S1, which are images for a glass slide with some stains on it. Both reflected and transmitted light have bright and dark field modes. However, dark field mode for transmitted light is not discussed here due to the weak signal of graphene foam under it.

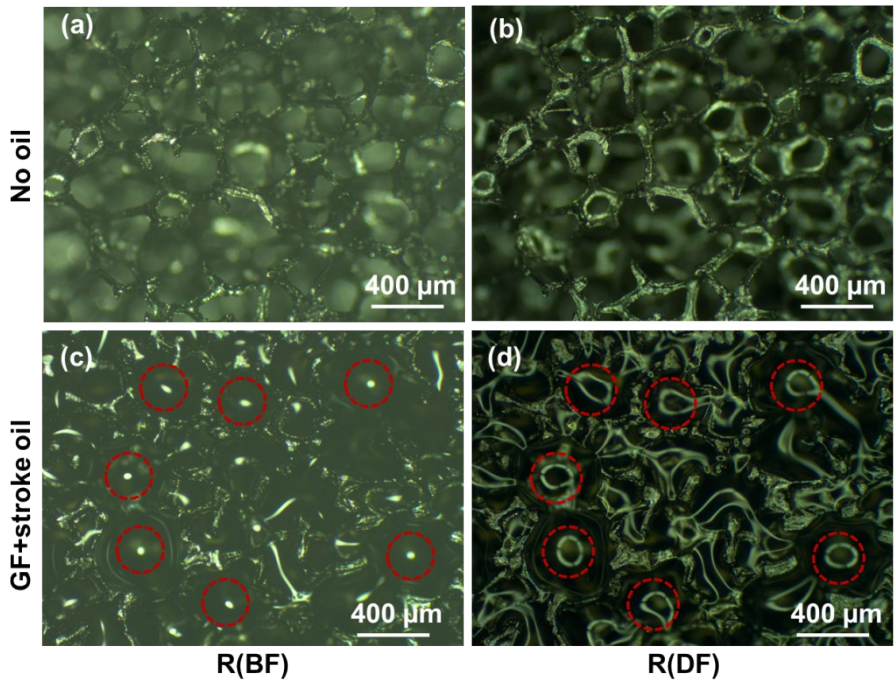
Phase contrast modes for transmitted light are shown in S1 (d)- (f). When light passing through different medium (medium with different refractive index or thickness), it will have different phases and this called phase shift, which couldn't tell by naked eyes. The phase-contrast method converts the small phase differences into intensity and colour differences which are visible to human eye with the aid of optical modulators, normally annular phase diaphragm and phase ring. For Zeiss A1 microscope, three phase rings Ph 1, Ph 2 and Ph3 for various medium numeral apertures are available. Compared with bright field image S1(c), stain on glass slide can be seen much more clearly with higher contrast with phase contrast modes.

These different modes can be used for differentiating graphene foam with or without oil easily, as demonstrated in S2-S5, from which clear differences between graphene foam without or with presence of the oil can be seen. The oil detection becomes much easier due to the "collector" behaviour of graphene foam. Moreover, reflected and transmitted light give different information of the oil.



S1. Images of glass slide with some stains under different detection modes of Zeiss A1 microscope. (a) Bright field and (b) Dark field modes for reflected light; (c) Bright field and (d)-(f) Phase contrast modes for transmitted light. Ph 1, Ph 2 and Ph 3 represent for different ring diaphragm, which can achieve various medium numeral apertures.

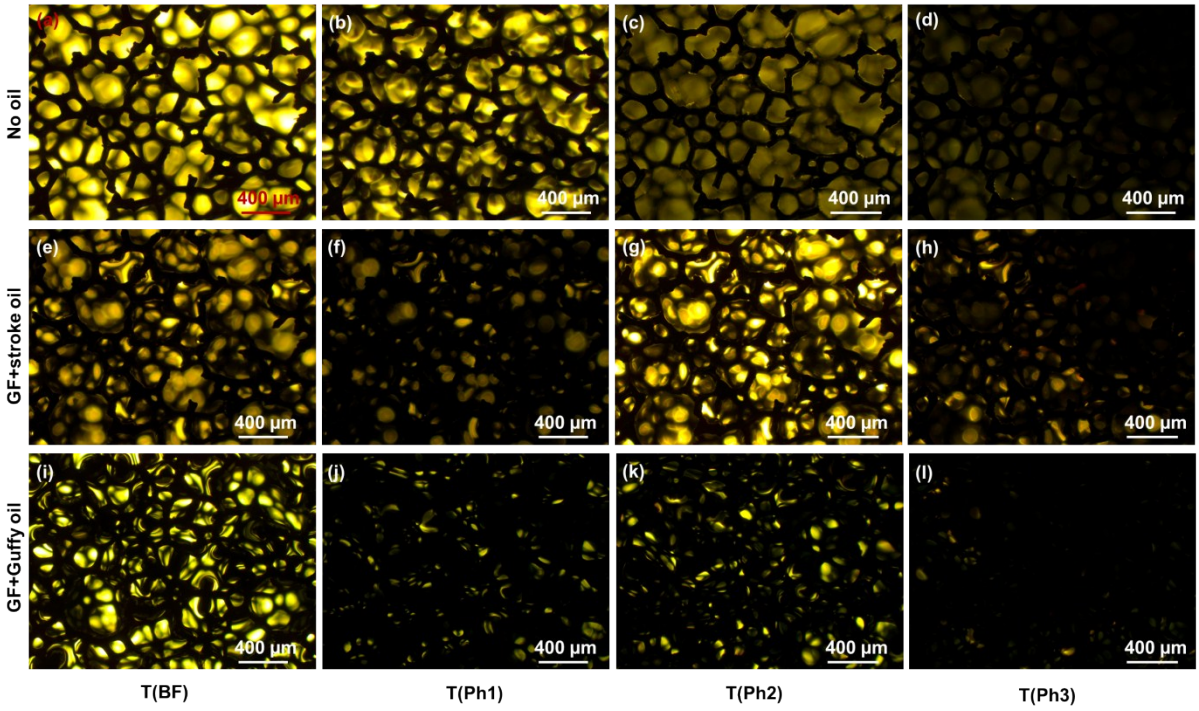
S2 demonstrates graphene foam (a), (b) without and (c), (d) with oil under only reflected light. As can be seen, both (c) bright and (d) dark field modes give clear oil information. The oil appears as bright dots or strips in the centre of the pores, while oil is in form of circles in dark field image (d), as marked by red circles. The dots distribution in bright field is correspond with that of circles in dark field, marked as red circles in images (c) and (d).



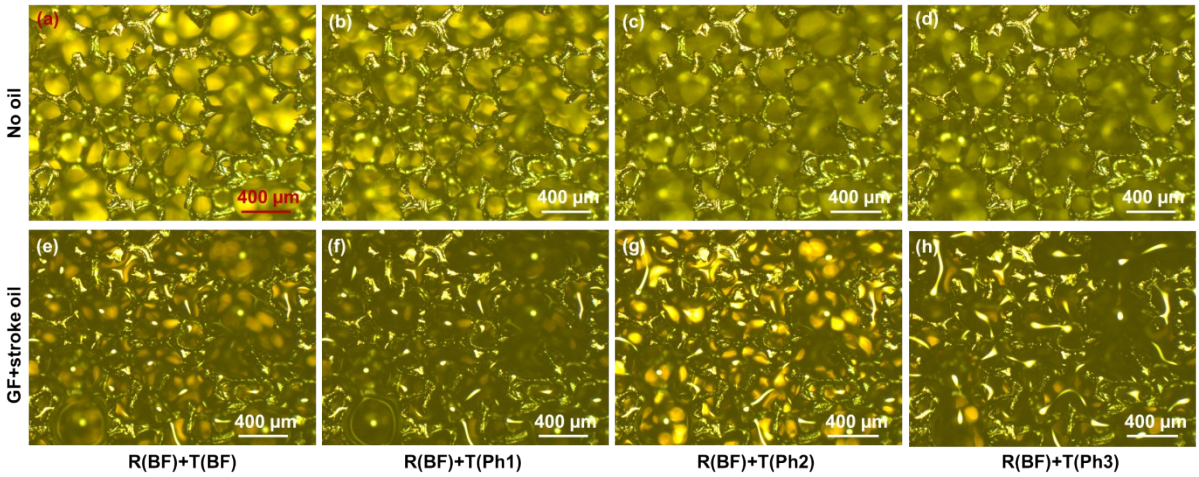
S2. Optical images with reflected light of graphene foam (a) , (b) without and (c),(d) with stroke oil. (a) and (c) are under bright field while (b) and (d) are under dark field.

The oil environments of graphene foam with only transmitted light were studied, as shown in Figure S3. Images of graphene foam without oil only demonstrating intensity difference while the foam with oil also shows colour difference, as can be seen red dots in Figure S3 (h).

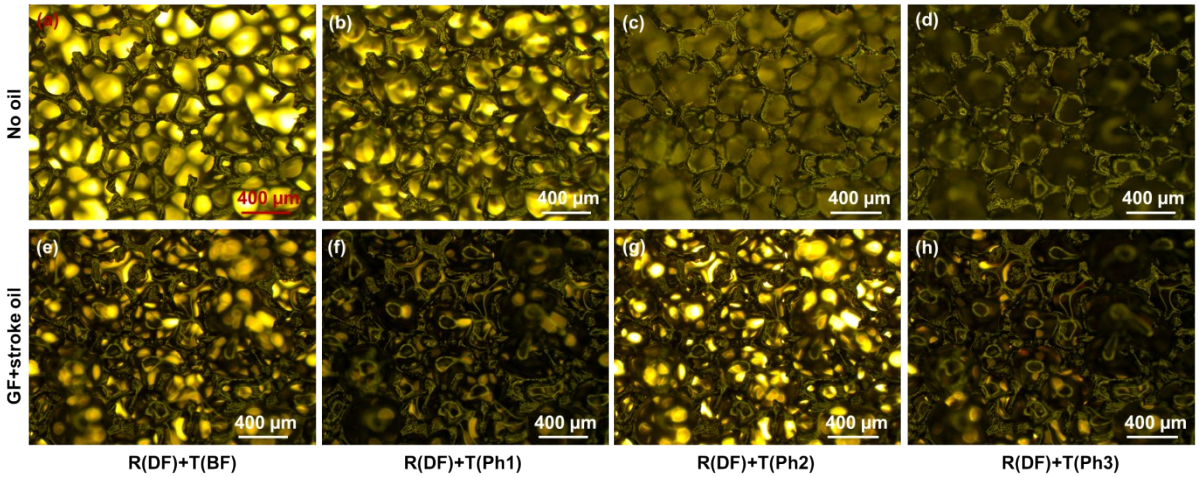
What's more, images can also be taken under both reflected and transmitted light to get more information, shown as S4 and S5, with S4 under bright field reflected light and S5 dark field reflected light.



S3. Optical images with only transmitted light of graphene foam (a)-(d) without , (e)-(h) with stroke oil and (i)-(l) with Guffy field oil . Images in the same column are at the same detection mode, with (a) bright field and (c)-(d) phase contrast modes.

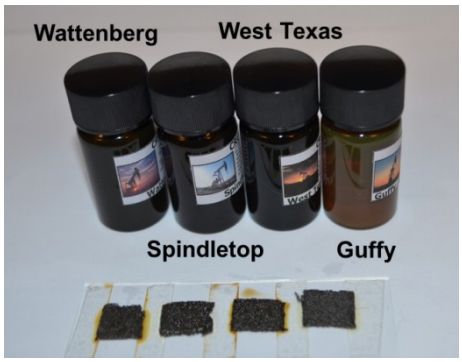


S4. Optical images under reflected (bright field) and transmitted light of graphene foam (a)-(d) without and (e)-(h) with stroke oil. Images in the same column are at the same detection mode.



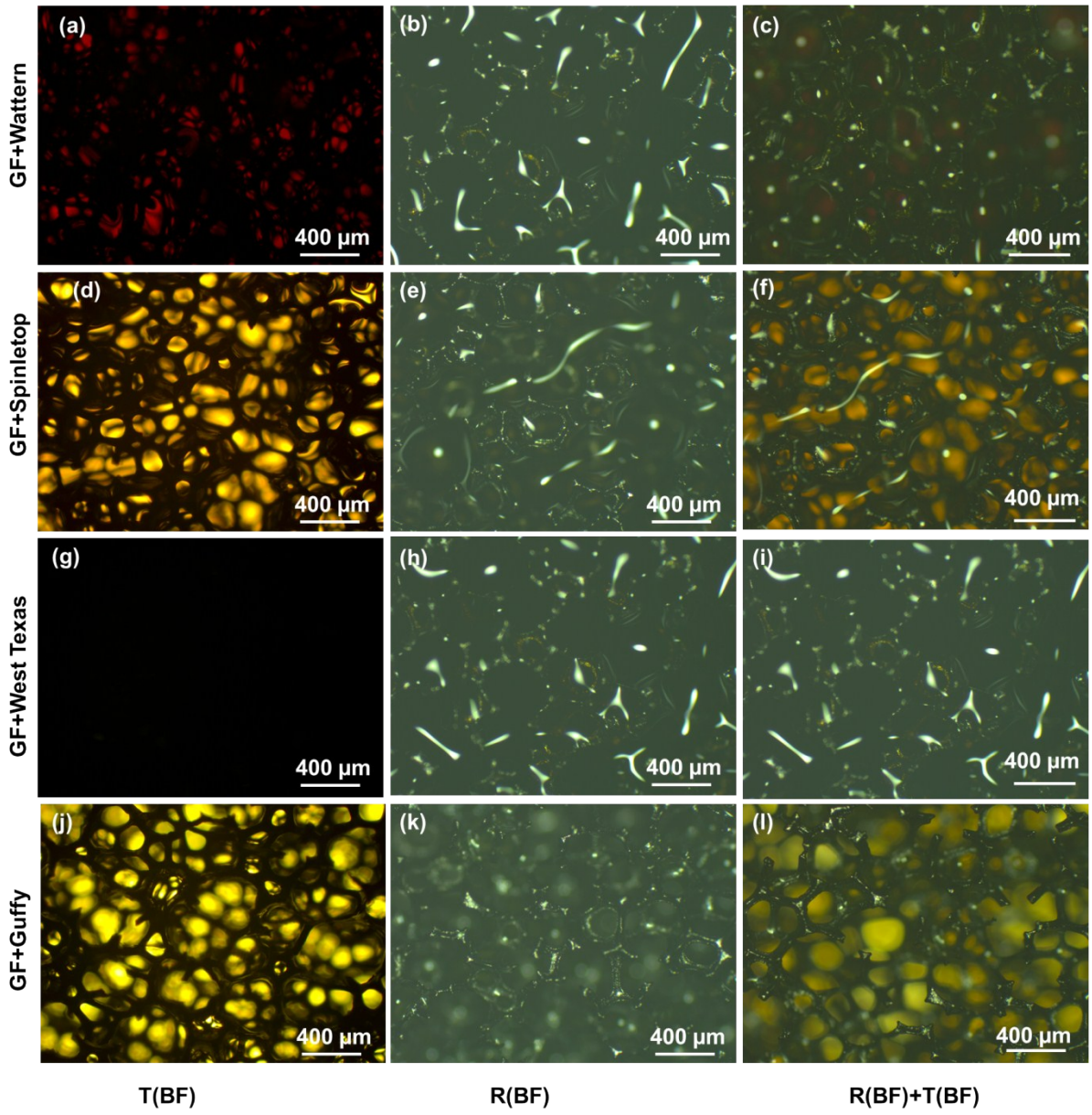
S5. Optical images with both reflected (dark field) and transmitted light of graphene foam (a)-(d) without and (e)-(h) with stroke oil. Four modes are shown, with each column is at the same detection mode.

Photo of graphene foams with crude oils is shown in S6.



S6. Photo of samples for crude oils, including Wattenberg oil, Spindletop oil, West Texas oil and Guffy oil.

Optical images of graphene foams with crude oils under various detections modes are shown in S7.



S7. Optical images of graphene foam with crude oils. Each row of the images are with the same oil, with (a) Wattenberg field oil, (d) Spindletop field oil, (g) West Texas intermediate oil, and (j) Guffy field oil; each column of the images are of the same detection modes, with the first column images taken under only bright field transmitted light, the second column images taken under only bright field reflected light, and the third column images taken under both reflective and transmittance light in bright field.