Electronic Supplementary Material (ESI) for RSC Advances.

Large area defrosting windows based on electrothermal heating of highly conducting and transmitting Ag wire mesh

S. Kiruthika, Ritu Gupta[#] and Giridhar U. Kulkarni[*]

Chemistry & Physics of Materials Unit and Thematic Unit of Excellence in Nanochemistry,

Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur P.O.,

Bangalore 560 064, India

[#]Author's Present Address:

Birck Nanotechnology Centre, Purdue University, West Lafayette, Indiana-47907, USA

S1-Characterization of crackle precursor

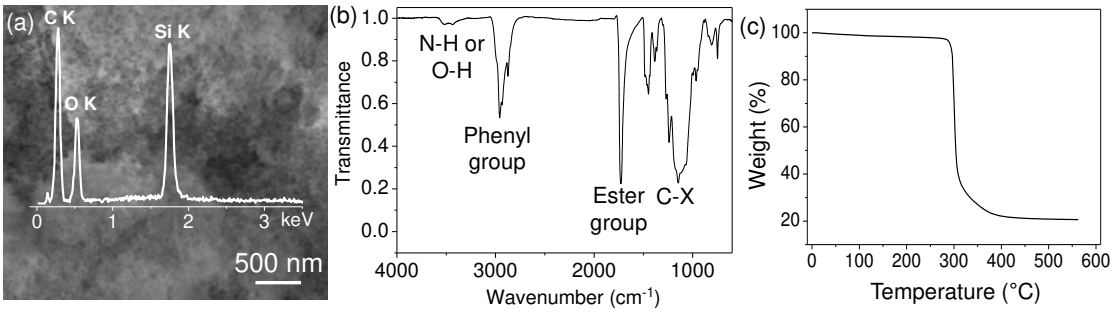

Fig. S1 (a) High magnification image of crackle paint and its EDS spectrum overlaid. (b) Infrared spectrum of crackle precursor. (c) TGA curve of crackling precursor shows that the decomposition starts around 300 °C and left behind SiO_2.

The crackle presursor is basically a colloidal dispersion of SiO_2 nanoparticles which is confirmed from EDS spectrum. IR spectrum shows the presence of ester based solvent in crackle precursor. Thermogravimetric analysis shows that crackle precursor start decomposing ~ 300 °C leaving behind SiO_2 (20%).

S2-Optimizing precursor concentration for interconnected crackle network

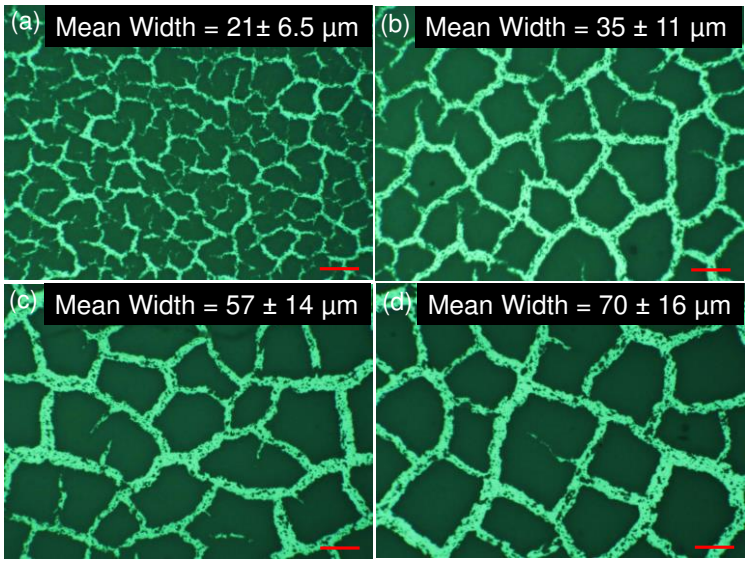

Fig. S2 The optical microscope images of crackle network formed by paint diluted with thinner for different concentrations. (a) 0.4 g/mL (b) 0.65 g/mL (c) 1.0 g/mL and (d) 1.1 g/mL. Scale bar 200 µm. The precursor solution of 1.0 mL was used for coating 18 cm^2 area, in each case.

The concentration of the crackle precursor is optimized to result in an interconnected crackle network (Fig. S2a-d). For lower concentration dispersion (0.4 g/mL), networks were less

interconnected (Fig. S2a) and for the higher concentrations (1.1 g/mL), wider crackles were obtained (Fig. S2d). The concentration of 0.6 to 1.0 g/ml was found to give highly interconnected crackles with narrow crackle width (Fig. S2b & c) on drop coating, which is further used in all experiments.

S3- Uniform wet layer coating

Fig. S3 Photograph taken immediately after drop coating of crackle precursor over glass substrate (37 × 25 cm^2). The film coating was smooth reflecting the image of a nearby tree.

S4- Optical microscope and SEM image of crackle network

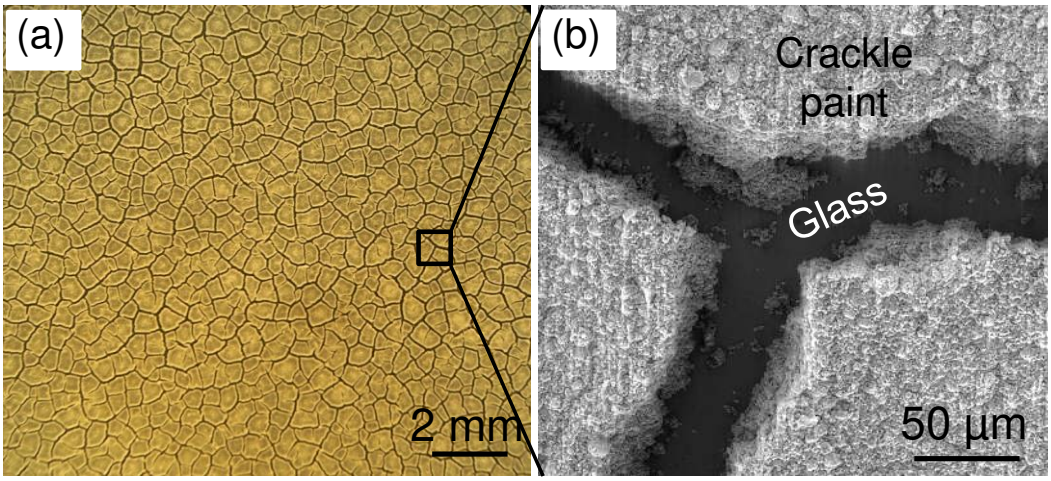

Fig. S4 (a) Optical microscopic image of the crackle network. (b) SEM image of crackles formed by the crackle paint over glass substrate.

S5 & S6 Crackle fill factor analysis

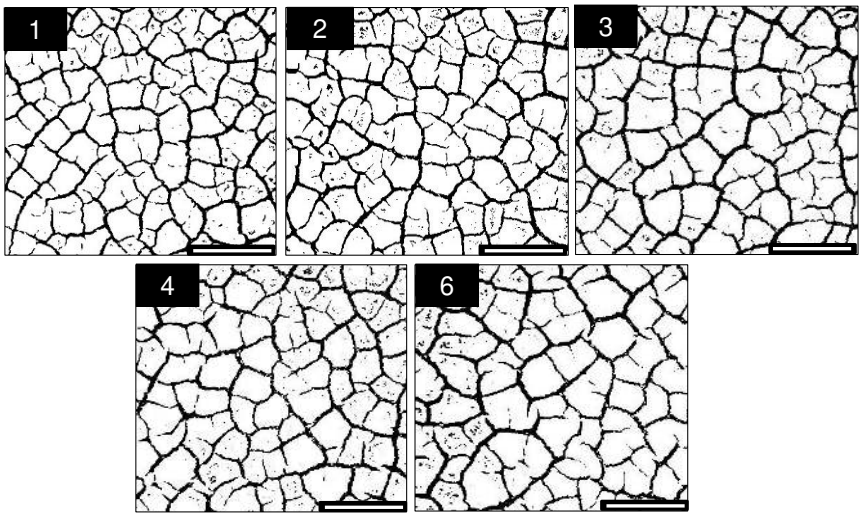

Fig. S5 Fill factor of crackle region from different position of large area crackle networks. Scale bar is 1 mm.

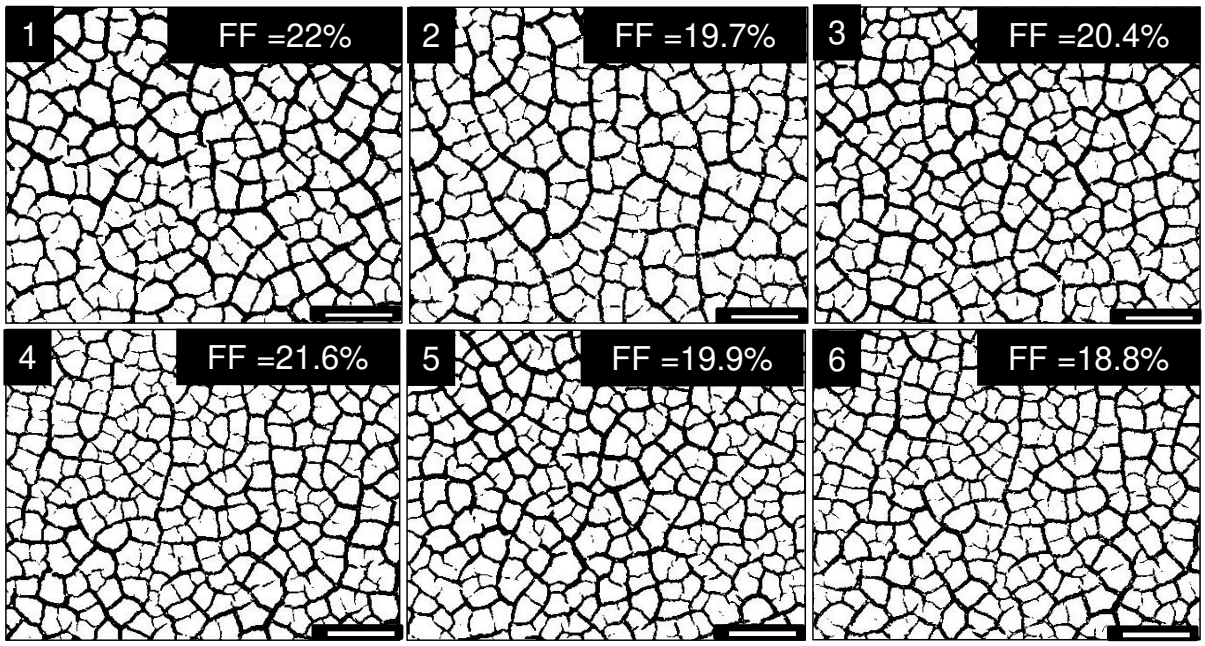

Fig. S6 The fill factor calculation on crackles formed at similar conditions over six different substrate. Scale bar is 1 mm.

S7- Template over large area by drop coating technique

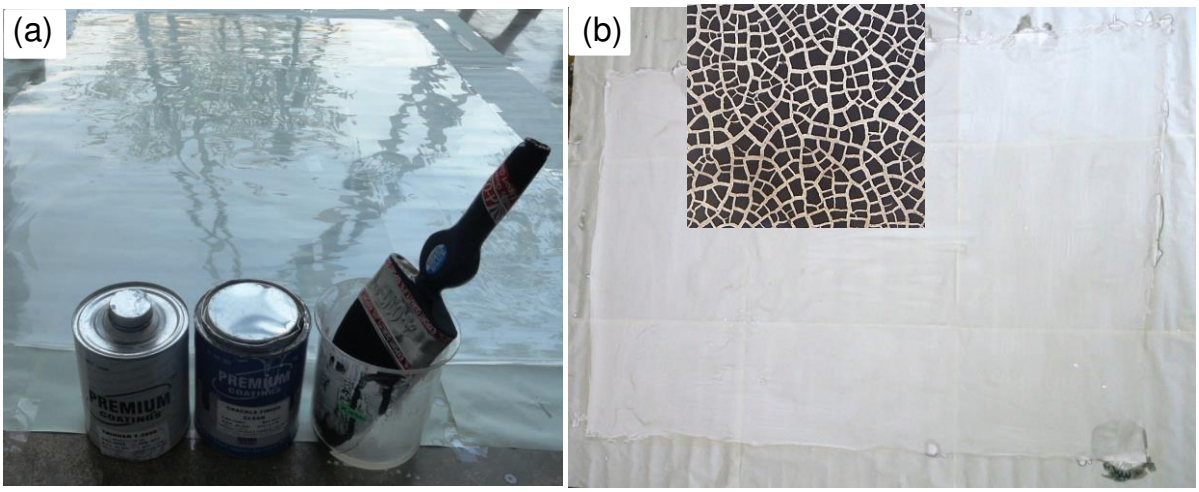

Fig. S7 (a) Developing crackle template by drop coating crackle precursor over 155 × 102 cm^2 PET substrate. The wet layer is left 2-3 h for self-drying. (b) The dried layer crackle itself and optical microscope image of crackled film is shown in the inset.

S8-EDS mapping of Ag mesh

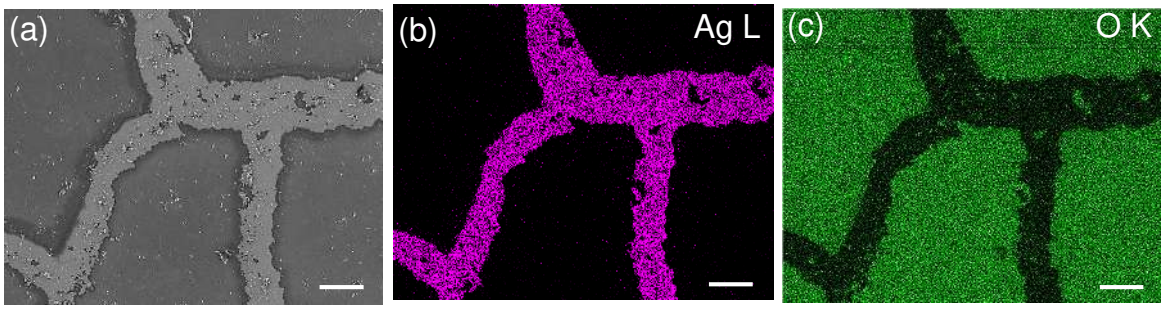

Fig. S8 (a) SEM image and EDS mapping of (b) Ag L and (c) O K signal from the patterned substrate. Scale bar is 50 µm.

The spontaneously formed crackles were used as template for deposition of Ag followed by removal of template layer leaving behind Ag only in the crackle grooves. The resulting Ag network was characterized by SEM along with EDS mapping from the same region (see Fig. S8a-c). EDS map clearly shows continuous Ag signal in the form of an interconnected junctionless wire (Fig. S8b). The O K signal in Fig. S8c is only present in the substrate (glass) area outside of Ag wires indicating that the Ag surface is clean and pristine.

S9-Average of transmittance spectrum (of Ag mesh) measured from 10 positions

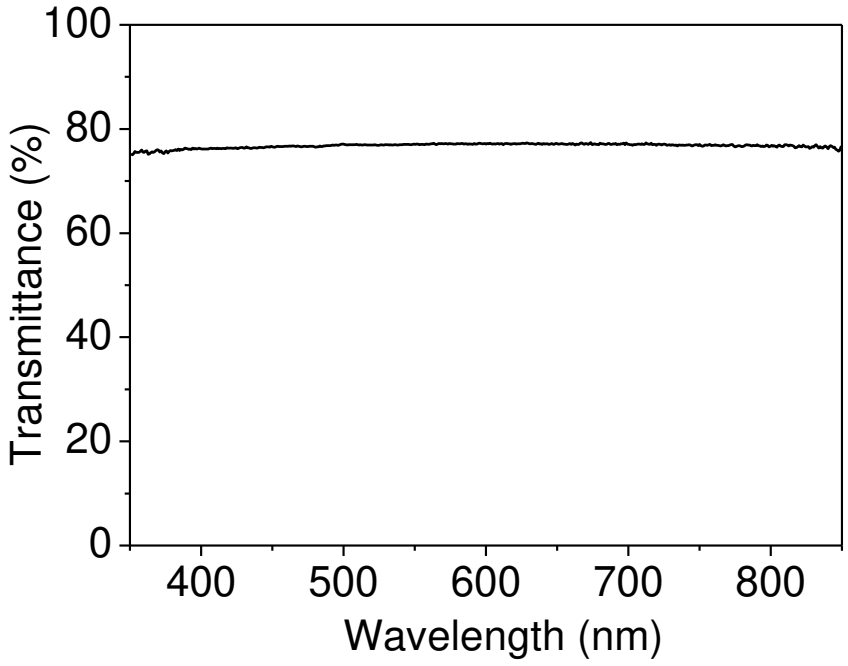

Fig. S9 Average of transmittance spectrum of Ag mesh measured from 10 positions.

S10-Transparent heater using Ag mesh

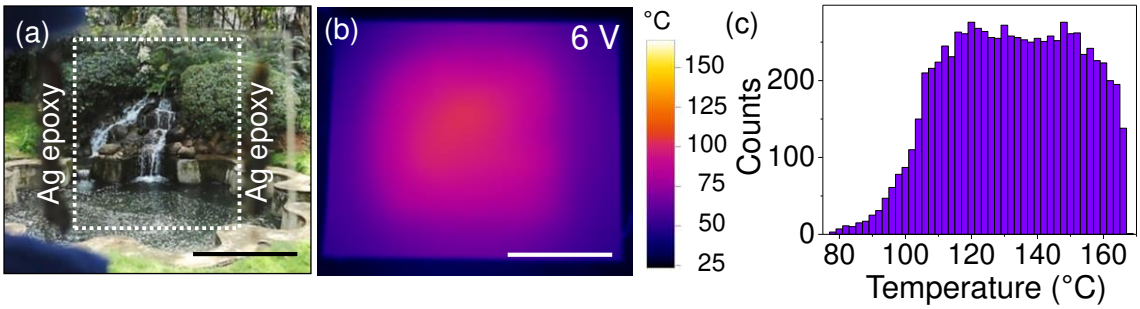

Fig. S10 (a) Photograph of the as-prepared Ag mesh fabricated as heater. Thermal image collected from backside of the TCE at 6 V (b). Scale bar is 1 cm. (c) Histogram showing the temperature distribution from marked region in inset of Fig. 4a.

A photograph of the Ag mesh fabricated as heater is shown in Fig. S10a. The water pond in the background illustrates the transparency of the heater. The Ag mesh electrode was tested for heater application by applying a DC voltage across the two Ag epoxy contact pads as seen in Fig. S10a. The temperature of electrode surface increases with increase in applied voltage. The temperature of the electrode raised to ~ 90 °C with 6 V (Fig. S10b). The distribution of temperature over the marked region in inset of Fig. 4a (9 V) is shown as histogram in Fig. S10c.

S11- Electrode stability for defrost cycling test

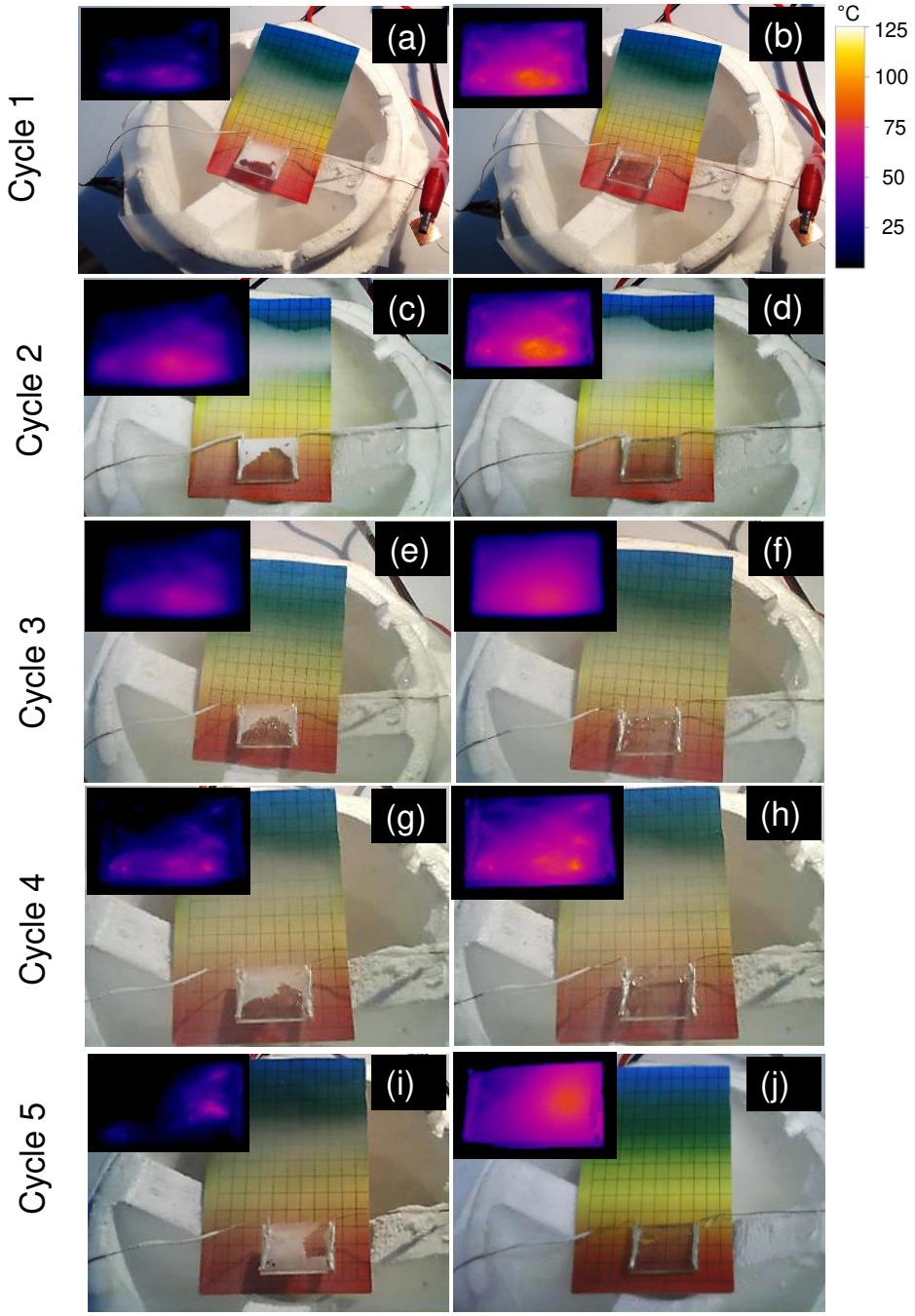

Fig. S11 Photographs on the left were taken while performing defrosting experiment and those on the right were captured after complete defrosting. The corresponding IR images are in the insets.

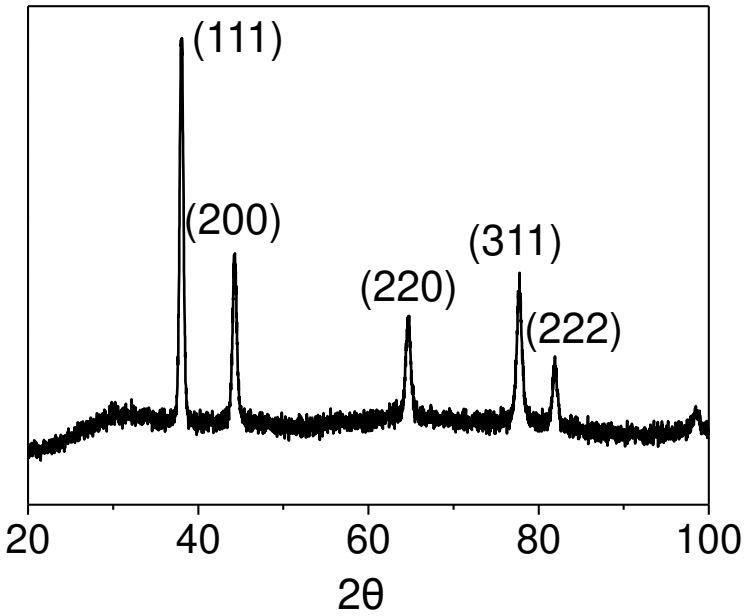

Fig. S12 X-ray diffraction pattern of Ag mesh after 6 h of exposure to LN_2 vapors and defrosting conditions. The peaks are matching well with Ag peak positions.