Supplementary Material (ESI) for Chemical Communications

Supporting Information

Inorganic Polymer Photoresist for Direct Ceramic Patterning by Photolithography

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1. COSY, ^{1}H-NMR, ^{13}C-NMR,

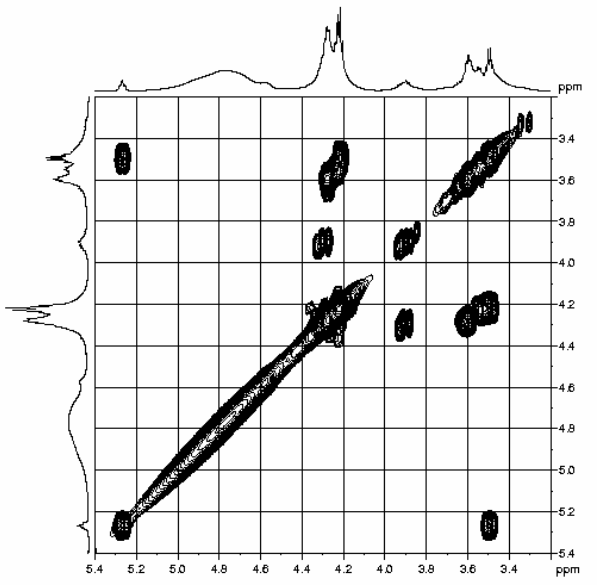

Fig. 1s (a) COSY spectra of HM-PVS

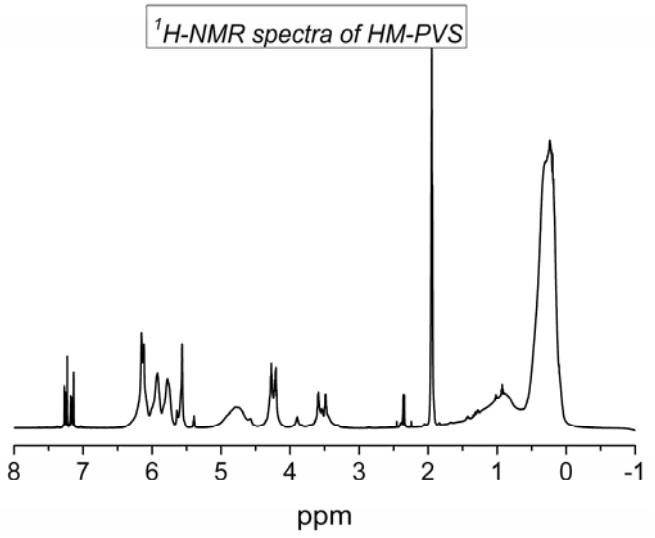

Fig. 1s (b) ^{1}H-NMR spectra of HM-PVS

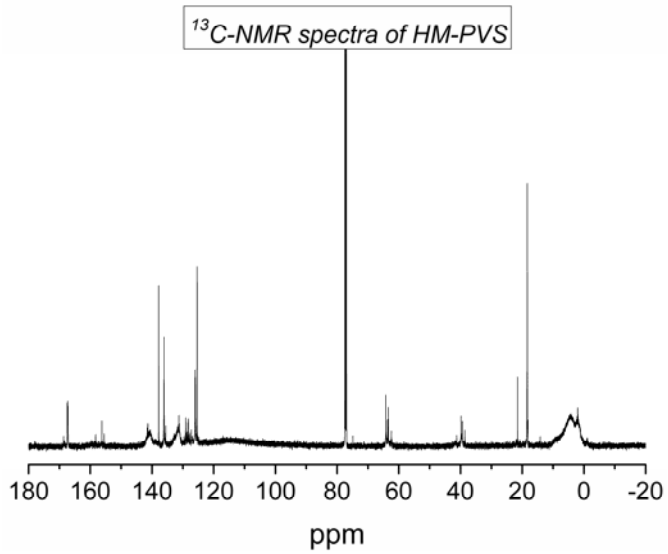

Fig. 1s (c) ^{13}C-NMR spectra of HM-PVS

2. Photopolymerization kinetic test

The mixture was prepared using 15 wt% synthesized polymer in $CDCl_3$ solvent, then 2-bezyl-2-(dimethylamino)-1-[4-(4-morpholinyl) phenyl]-1-butanone (Irgacure 369) as a photoinitiator was added (2 wt% of synthesized polymer). All samples were prepared in NMR tubes and then exposed in UV for 0, 10, 30, 60 sec. ^{1}H-NMR analysis was conducted immediately after illumination.

3. TGA data

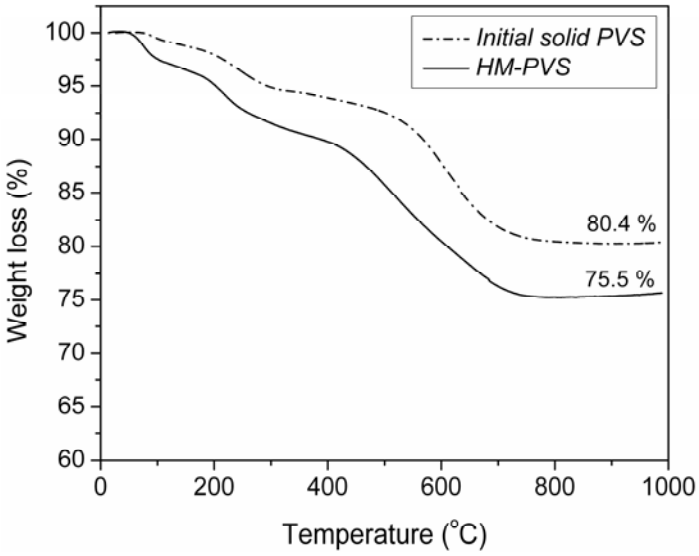

Fig. 2s TGA curves for: initial solid PVS and HM-PVS

4. Nano-indentation test

For evaluation of mechanical property, the as-synthesized HM-PVS resin solution of 50 wt% in toluene was dropped onto 2x2 cm Si(100) wafers and then spun at 2000 rpm for 30 sec using a model PM101DT-R485 spinner (Head-way Research Inc.). The coating process was carried out inside a glove bag in a nitrogen or argon atmosphere to avoid the exposure to moisture. The polymer films were cured by UV exposure at 20 mW/cm^2 for 10 min and then annealed at various temperatures (100^{o}C to 800^{o}C) in a tube furnace in a nitrogen atmosphere at a heating rate 2^{o}C min^{-1}, and then kept for 2 hrs. The modulus of the pyrolyzed films were evaluated by using Nano Indenter equipment (Nano Indenter XP, MTS) with low force to high force range and also include CSM mode.

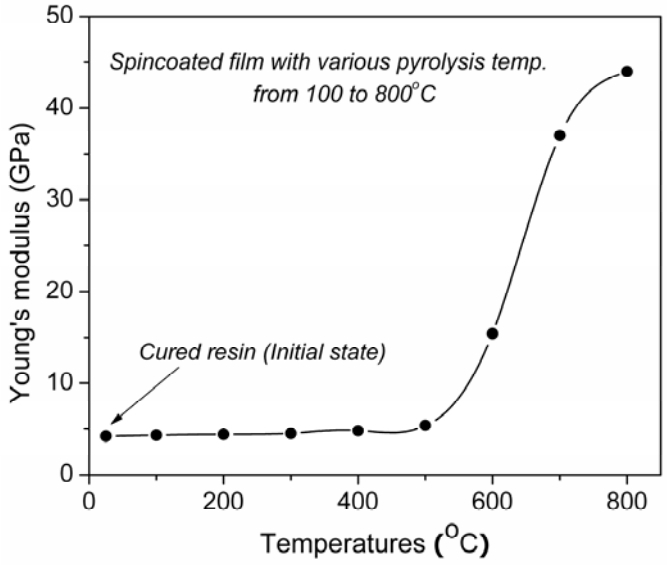

Fig. 3s Dependence of Young's modulus on various spin-coated films at differential temperatures

5. Direct fabrication of ceramic structures via photolithography process

5.1 Mixture preparation

The mixture was prepared using 25 wt% synthesized polymer in tetrahydrofuran anhydrous 99.9%, then 3 wt% of Irgacure 369 photoinitiator was added. After stirring, the 0.2 μm filters was used and the bubble in mixture must be removed for uniform coating layer.

5.2 Fabrication of ceramic structures

The photographic processes consist of (i) dynamic spinning of the mixture, (ii) 10 sec at 1000 rpm, and 30 sec at 2000 rpm, (iii) soft baking process for 2 min at 55 °C , (iv) UV exposure at 30 mW/cm^2 for 40 sec (MA6 aligner, Karlsuss), (v) develop with ethanol for 15 sec at room temperature, (vi) Blow residual developer with N_2 gas, (vii) post bake process for 15 min at 110 °C . Finally, the developed solid polymer samples were annealed in a tube furnace at 800^{o}C in a nitrogen atmosphere for 2 hrs with a heating rate of 2^{o}C min^{-1} to produce the ceramic phase.